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BRIEFLY TOLD.

THE MINNEAPOLIS (MINN.) ARBITRATION.—Minneapolis is beyond doubt a pretty city and the people there are proud of its growth, in that the latter is proof positive of its capacity for going on to a greater state. They also claim to be eager to gain for it a still greater pre-eminence in the domain of manufactures, for although its specialties in the commerce of America are flour and lumber, its ambition is to add to these as many other branches as it profitably may. Territory and to spare it has for innumerable sites for mill and factory, forge and workshop, and to those who would venture on any manufacturing line within its borders, as newcomers, Minneapolis holds out a warm welcome. Now, while all this is praiseworthy and meritorious, one should not overlook the fact that the enterprising manufacturers who have toiled within her dominion for years, and who by their pioneer efforts have more than had a fair share in her development, should not be given the cold shoulder, nor be treated with an indifference that is almost as positive as the welcome which is tendered to the coming investor. In the abstract it is all very well to nod carelessly to the citizen whom you have had with you for years, while the newcomer is greeted with an effusiveness that even borders on the slopping-over point; but in the concrete the citizen who has borne the blunt of time (in the items of having paid his taxes with regularity for two or three decades and of having paid his just obligations as he went along), without shrinking or shirking, is a pretty good fellow to have around. Bearing these things in view, Minneapolis for years has had the benefit of capital invested by private parties in a gas enterprise, which has been capably managed, and which has given satisfactory service to the people of that city; not that the gas works has ever been conducted on the principle that it was in existence other than for the purpose of yielding a fair profit to those who controlled it, nor can it be successfully said that its owners ever got more than a fair profit out of it. However, there came a time when the city authorities thought that the gas rate was too high, and this thought, which, as is usual in such cases, was born of a desire of those in authority to make political capital for themselves at the expense of some one else, was urged until the press and the people finally became interested. There was a common cause for interest, too, in that all—authorities, press and people—could, by securing a reduction in the gas rate, obtain gain for themselves, without other expenditure than that of wind. Some of the most hot headed (as usual, these were the ones who knew least about the ethics of the thing), were clamorous for gas at a dollar a thousand, failing which immediate "relief," they counselled the revoking of the Company's charter or the engaging of the city at once in the manufacture and supply of gas on public account. Wiping out an existing corporation is, however, an extremely difficult task, for incorporated companies of long and honorable standing usually have some champions, and even though the latter might reasonably be supposed to include people interested in their shares, their influence is none the less potent on that account. So it was with the Minneapolis Gas Light Company, for when the shouting about dollar gas and municipal control had lost some of its sonorousness, propositions looking to a settlement of the matters in dispute were made. Some of these originated with the authorities and others emanated from the Company, but all were too wide of agreement in their essentials to admit of a compromise. Finally, the idea of arbitration was broached, after many months of vain attempt to dispose of the question otherwise, and the details of the same were arranged. Under the agreement the Board of Arbitrators was to have a membership of three, one of whom was to stand for the city, one for the Company, and one to "have no bias whatever." The Board as constituted was: Gen. G. P. Wilson, B. F. Nelson and W. J. Murphy—the latter representing the Company. In due time the Board got down to work and public hearings were held, at which some remarkable testimony respecting certain photometrical examinations of the gas supplied by the Company, and some equally astonishing analyses of its composition as a gas were submitted on behalf of the city, together with expert testimony as to what a gas of the kind manufactured and sold in the city should cost the producer—quality, sendout, nature of works and mains, cost of materials and of labor, all being given due consideration. The city secured a most competent chief expert in the person of Mr. O. N. Guldlin, of Fort Wayne, Ind., who was at once honest with the city and unwilling to persecute the Gas Company, and we venture to assert that much of what he so openly and frankly testified to, which was all within the bounds of truth and fairness, was quite in the nature of a

revelation to the city's representatives, who, no doubt, thought that when the Gas Company was put on the examination rack it could not conceal the tremendous profit there was in selling gas in Minneapolis at $1.60 per 1,000 cubic feet. The Company's case was ably presented (the expert witnesses on its behalf included Capt. White and Mr. A. E. Boardman), and when the testimony was all in it was the general impression, as reflected by newspaper comment, that whatever the ultimate decision of the Board was, Minneapolis could not reasonably expect a large reduction in the charge for gas. On the 3d inst. the Council received majority and minority reports from the Board, the former (signed by Messrs. Nelson and Wilson, and the latter by Mr. Murphy), stating that a fair price, in their judgment, would be $1.30 per 1,000. Mr. Murphy, however, gave it as his opinion that the prevailing rate was none too high, and recommended its retention, submitting this on the belief that a dividend return of 10 per cent. on the Company's capital was not excessive, whereas the majority held that an 8 per cent. dividend was sufficient. The reports were filed, and we will defer further comment on the matter until its final settlement causes it to become an open topic for criticism.

[Written for the JOURNAL.]

The Effect of Elevation on Pressure.

By MR. FRED N. MORTON, M.E.

Among the various formulæ that have appeared for computing the rate of flow of gas through pipes, none, as far as I know, has ever taken into consideration the variations in pressure due to elevation. It is well known that the pressure of gas at the top of an ascent is greater than at the bottom, and *vice versa*, and that this should be taken into consideration when calculating the size of pipe required to carry a certain amount of gas. In his "Treatise on Coal Gas," King says that, for gas of 0.32 gravity, the increase of pressure due to elevation is 1 inch per 100 feet. This is perfectly true; but as gas is seldom of that density the rule is apt to be misleading, especially as no explanation accompanies the statement.

In the following discussion, let—

P_a equal the absolute pressure of air at the bottom of the elevation.
p_a equal the absolute pressure of air at the top of the same elevation.
W_a equal the weight of a column of air due this elevation.

Similarly, let P_g, p_g and W_g equal respectively the pressures and weight of a column of gas of equal height.

Then, $P_a = p_a + W_a$,
And, $P_g = p_g + W_g$,
Or, $W_a = P_a - p_a$,
And, $W_g = P_g - p_g$.

Subtracting, we have—

$$W_a - W_g = (p_g - p_a) - (P_g - P_a).$$

But $(P_g - p_a)$ and $(P_g - P_a)$ equal respectively the pressures of the gas in the pipe as indicated by pressure gauges. Now, as air is heavier than gas, W_a will exceed W_g, and each term of the equation will be positive, and the pressure, as indicated by gauges at the top of the elevation, will be just as much greater than at the bottom as the difference in the weights of columns of air and gas of a height equal to the elevation in question.

To simplify this equation we will let G equal the gravity of gas as it is usually expressed—*i. e.*, in terms of the weight of air—and p and P the pressures respectively at the top and bottom of the elevation, as indicated by gauges. Then—

$$G = \frac{W_g}{W_a} \text{ or } W_g = G W_a,$$

$p_g - p_a = p$,
And $P_g - P_a = P$.

Substituting these values, we have—

$$W_a (1 - G) = p - P.$$

A column of air 100 feet high exerts a pressure of 1.473 inches of water. If the gravity of the gas be 0.32, the difference in pressure for each 100 feet of elevation will be—

$$1{,}473\ (1 - 0.32),$$

or practically 1 inch. This is the origin of the rule given by King, and mentioned above. It is, however, an extreme case, 0.32 being very light even for coal gas. Taking 0.45, which is nearer the average, the increase of pressure due an ascent of 100 feet will be 0.81 inch. With water gas of a density of 0.65, the pressure will rise 0.51 inch, or practically half an inch, for each 100 feet of rise.

Comments on Mr. Newbigging's Paper on "Illuminating Power and Illuminating Effects."

By Mr. J. P. GILL.

The paper read by Mr. Thomas Newbigging before the Incorporated Gas Institute, which was printed in the AMERICAN GAS LIGHT JOURNAL for July 16, is interesting as well as instructive. The clearness, positiveness and enthusiasm with which his views are expressed render it impossible to doubt his sincerity. While according the full meed of praise for his ability and honesty of argument, there is room to doubt the correctness of the position he has taken. It is very doubtful if many gas engineers will accede to a statement that 14 or 15-candle gas is as good for the consumer as a 16 or 20 or 24-candle gas, although the claim is made that some of the ablest and most experienced gas engineers and gas chemists cherish such views. That, for instance, 20 grains of carbon heated to the same degree of whiteness as 12 grains would not give practically 1⅔ times as much light, will not be assented to by the ordinary or by the instructed and logical mind. That a 14-candle gas, containing about 2½ pounds of illuminating carbon per 1,000 cubic feet of gas, will give as good and useful a light as a cannel gas containing about 8¾ pounds per 1,000 cubic feet, other things being equal, is incredible. It may be asserted, without fear of contradiction, that no consumer who has been accustomed to the use of a 20-candle gas, consumed in a proper burner, which will heat to whiteness the particles of carbon and permit them to be converted into carbonic acid gas before they leave the flame, will ever be willing to return to the use of a 14 candle gas. If such a change for the worse should be attempted to be imposed upon the body of consumers, there would be such a cry of indignation that the gas producers would soon find themselves upon the stool of repentance and in haste to amend their ways.

The writer of this article has had ample experience in this particular line. Some years ago he had charge of a gas works in a manufacturing town in which there were a number of large mills—cotton, woolen, etc. At first the quality of gas made was, as usual in those days, of about 14 or 15-candle power. But the cry was continuous for more light. The operatives could not see to do their work perfectly and successfully. The floors or rooms were gloomy, and the ethical effect was injurious, going so far as to affect the spirits and health of the operatives. The illuminating power was gradually raised to 16, 18, 20 and 22 candles. There were then no further outcries. The rooms were light and cheerful, producing an effect upon the operatives in harmony therewith, and all of the work was successfully carried on. Any attempt to lower the standard was followed by a corresponding notice at headquarters. Now, the question will naturally be asked, what was the result financially? The reply is, satisfactory. The enrichment was made by the addition to the ordinary gas coal of 10 per cent. of cannel coal, more gas was made per ton, an increase on the average of about 20 per cent. greater profits and an enlarged sinking fund for renewals and extensions were realized. A gas of 18 candles or so, if properly made, can be produced as cheaply as a 14-candle gas as often made, say, by our cousins across the water. It need only be added that proper care was taken to secure proper burners, and attention was given to the mode of combustion. This, of course, in any case is important.

Mr. Newbigging objects to an enriched gas of 18 or 20 candles for various reasons, such as its varying quality, its stratification, and the deposition of the hydrocarbon vapors in the pipes, etc. It may appear rather blunt to say that none of these direful evils need attend the use of a high illuminating gas. The difference in results depends entirely upon the way in which the gas is manufactured. The present writer knows that, in a gas district extending 7½ or 8 miles from the works, no trouble arose from sending a gas of 25 candles that distance; there was no loss of illuminating power, the gas being as good at the termination of that distance as at the beginning, and there was no pumping required of hydrocarbon vapors from the street drips. Such facts will be better known and experienced as opportunities develop. It is to be hoped that the remark will not be considered invidious or disrespectful, that professors, with an extended experience, will have to revise and qualify their opinions.

It would seem to bear rather hard on that class of consumers, who may reside at a distance from a good bituminous coal field, to confine them to the use of a poor illuminating gas to be got from an inferior quality of coal, because that coal happens to be in a locality nearer to them than better coal. This would inevitably be a never ending cause of dissatisfaction; no one, it would seem, would be willing to be restricted to the use of a 12 or 14-candle gas when his neighbor of 50 or 100 miles was enjoying the benefit of a gas of 18 or 20 candles, and merely for the reason that he was somewhat nearer to a good coal mine

The public spirit and enterprise of such a community would apparently consist in patience under affliction. This is a good maxim when the affliction is unavoidable ; when avoidable, enterprise would suggest a different policy.

Again, it might be asked why a community should be confined to the use of a poor quality of gas, while incandescent lighting is being developed. It would exhibit a higher regard for the interest of the community to supply it with a good quality of gas until the system of incandescent lighting should be perfected ; when that point should have been reached, the quality of gas might be lowered to suit the new conditions. This course would be logical the other illogical.

It is pleasant to be able to say that there is one remark of Mr. Newbigging to which all may subscribe, that is with reference to the difference between the quantity and intensity of light. There is a similar difference in this respect as there is between the quantity and intensity of electricity ; *i. e.*, between the ampere and the volt of the electric current. The writer has had frequent opportunity to notice the difference between a gas light and the light of a kerosene lamp. The gas light has more quantity and is more diffusive; the light of the kerosene lamp has more intensity, but is more concentrated and localized. This has been often noticed in small stores, where the proprietors have, in dull times, tried to make, or rather to save money by utilizing their own labor to fill and trim lamps to use, instead of burning gas. Let anyone of an evening enter such a store, and he will notice that while there is a strong and bright light under and near the lamps, the store generally is not bright looking ; the shelves, for instance, not being well lighted up. Let him go into the same store on some succeeding night when it is lighted with gas, and he will notice a striking difference. The gas light seems to fill the whole space between the walls of the room, the effect is more cheerful and the shelves much better lighted. The difference consists in the fact that gas light has quantity or volume and the kerosene light intensity chiefly.

Secondly, place a kerosene lamp alongside of a good gas light. The observer standing near the two lights will notice that the oil light appears to be bright and dazzling, while the gas light appears to be bluish and dull. Let him go 15 or 20 feet from the lights and then turn and face them. He will notice that a remarkable change has occurred during his short trip ; the gas light is the bright one and the oil light the dull one—showing that the gas light has quantity or volume and diffusiveness, and the kerosene light intensity and concentrativeness. All this is true and interesting, but does not at all prove that a light having quantity with little intensity is as good as a light having both quantity and intensity. A gas light of 12 candles has quantity with little intensity, while a 20 or 25-candle gas light, having more quantity because of the greater number of carbon particles to be rendered incandescent, has at the same time more intensity arising from the fact that the carbon particles are more highly heated, and therefore have a more intense power. Quantity is good, but quantity and intensity combined can be said to be very much better. What would quantity of steam be worth without pressure to give it working power? Quantity and pressure are to steam what quantity and intensity are to light. There being methods of ascertaining both the quantity and intensity of the electric current, it is very much to be wished that there may also be ways found of ascertaining those differing properties of light.

[Concluded from page 190.]

Smoke-Preventing Appliances.

[Read by Mr. W. P. Sicard, before the Franklin Institute.]

We will now proceed to consider some of the devices that have been proposed for smoke prevention.

In the first system which we will look into, the inventor states that his invention relates more particularly to obtaining practically perfect combustion of fuel in a boiler furnace, and to increasing the steaming capacity of the boiler, by preventing loss by the too free escape of heated gases, thus effecting economy in the use of fuel. He argues that heretofore the efforts that have been made to effect perfect combustion by means of forced draught have failed, because either too much or too little air under pressure was introduced to effect the required combustion, and because the heated products of combustion, principally carbonic acid gas and the nitrogen, the latter constituting the incombustible element of the air introduced, were allowed to escape too freely and at too high a temperature, thus carrying away the heat which should have been communicated to the water in the boiler and used to make steam. In this system the boiler is provided with a tight ashpit and a tight furnace. Into the ashpit is introduced a sufficient quantity of air under pressure to properly combine with the fuel, and no more. To prevent a waste of heat the smoke box is closed directly above the tubes, leaving only an opening of restricted but regulable area for the escape of the products of combustion. Into the furnace is introduced the proper quantity of air for the purpose of supporting combustion, taking into consideration, and making proper allowance for, the nitrogen constituting the incombustible element of the air introduced under pressure, and taking from the furnace only the results of such combustion. To properly effect this result with a given weight of fuel per hour, the necessary volume of air to combine with this weight of fuel is introduced into the tight ashpit, and the area of exit is adjusted in accordance with the principles stated. With this arrangement no chimney or stack is considered necessary, except when starting the fires, save such as shall serve to carry off the incombustible gases which reach the smoke box.

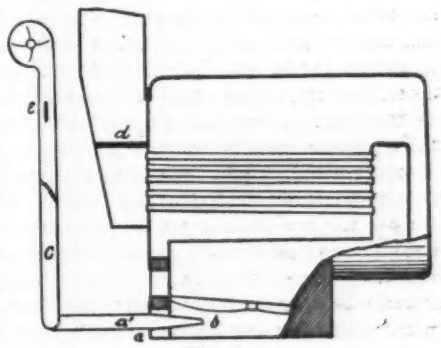


Fig. 1.

In the accompanying sketch, the parts are so easily distinguished as almost to need no explanation. The ashpit is closed by the doors *a*, through which pass tubes *a'*, having nozzles *b*, preferably with long and narrow mouths, for delivering the air supply. The main supply pipe *c* is furnished with a damper *e*, by means of which the air under pressure may be shut off at will. The air pressure is furnished by a fan. The damper or diaphragm *d* can plainly be seen directly above the tubes and, when the boiler is steaming, this closes off the smoke box completely, except for the small apertures left for the escape of the incombustible gases. The system of operation is as follows: The fire having been lighted, air under pressure is admitted under the grate, the oxygen producing rapid combustion. Until the fire gains some headway, the damper *d* is left open, and the smoke and gas escape through the flues as in the ordinary system. As soon as combustion is fully established, the damper must be closed, thus closing completely the space between the tube sheet and the front door of the smoke box. There is still, however an escape for the incombustible gases, through the holes in the damper before mentioned. By this means the stack is practically closed. The release of these incombustible elements is effected by the draught of the stack, as in ordinary practice, or by a steam blast, which may be placed, through the damper, to the base of the stack. This steam blast is considered necessary in the locomotive class of boilers, where rapid steaming and consequently rapid liberation of these incombustible gases is required. The inventor claims to have found that the best results are produced by placing the damper in the smoke box, almost immediately above the upper row of tubes, so that the heated incombustible gases shall be detained, or temporarily held back in the smoke box and below the water line of the boiler, before they are finally delivered to the stack through the holes in the damper. All the units of heat, temporarily retained below the water line, are conducted to the water and help to make steam, while those carried above the water line have the effect of superheating the steam. On these grounds he bases the claim that the damper placed in the chimney is not the equivalent of a damper placed in the smoke box near the water line. It may be interesting in this connection to append the results of a test recently made in Richmond, Va.:

Diameter of boiler	48 inches.
Length of boiler	14 feet.
Number of tubes	49.
Diameter of tubes	2.75 inches.
Grate surface	20 square feet.
Duration of test in each case	10 hours.

	1st Test, Without Blower.	2d Test, With Blower.	3d Test, Without Blower.	4th Test, With Blower.
Pounds coal used during test	1,846.75	1,771	1,591	1,377
Pounds water used during test	12,715.74	13,602.89	10,078.45	10,967.72
At temperature of	95°	95°	84°	81°
Evapor'n to steam pressure of.	75 lbs.	70 lbs.	69 lbs.	73 lbs.
Water evaporated from 212° to steam at atmospheric pres.	15,667.5	16,704.34	12,215.06	13,654.81
Water in pound, evaporated per pound of coal	8.48	9.73	7.84	9.91
Saving of coal		12.84%		20.88%
Air pressure in ins. of water.				.75

These tests show a saving in coal of 12.84 per cent. and 20.88 per cent.'

respectively, and the engineer in charge of the tests mentions that there was an almost total absence of smoke even immediately after firing.

The second system is not so simple, and you will notice its complete difference from the former one. The object of this system is to effect the perfect combustion of smoke and gases generated in the use of bituminous coal and similar fuels, and also to increase the steaming capacity of the boiler. The inventor, in his description, says that, as understood by those familiar with boiler furnaces, the fuel gases enter the flues from the fire box in a partially consumed condition, and it is found that the water surrounding the flues partially cools them, thereby extinguishing the flames and causing the gases to pass through the flues in the condition of smoke. In cases where the gases arising from the burning fuel come in contact with air of lower temperature, the ignition of such gases is prevented, or, if ignited, the flame is liable to be retarded or even extinguished. This, he says, may be overcome by properly heating the air and then admitting it to the furnace, under proper conditions and in proper proportions, so that a practically perfect combustion will be obtained. It is also important that such heated air be introduced at the proper place. If it be introduced too near the boiler flues, it will readily escape and the result sought for will be lost. If, however, it be introduced at a point remote from the boiler flues, as, for instance, from above the furnace door to a little beyond the center of the fire box and above the bed of the fuel, and also in the bed of fuel, almost perfect combustion is attained and the intensity of the flames is increased. This will give an indirect course to the heated air and a better opportunity for its mixture with the heated gases. Hence the value of fuel does not depend solely on the quantity of air supplied thereto, but also upon the condition of the air and the manner of its application.

Working upon these assumptions, they have constructed their furnace so that, if desired, the air may be supplied in three volumes, one of which enters the firebox through the grate bars, generates the gases from the coal, as in a gas producer, and partially consumes them. The other volume of air, which has previously been heated, enters through an air duct directly into the mass of burning fuel, mingling with the generated gases and partially consuming them, while the remaining volume of air, having also first been heated by passage through a coil of pipe over the firebox, enters the firebox, preferably at a point remote from the boiler flues, and mixing with the partially consumed gases, completes their combustion and produces intense heat. The means employed for heating and introducing the air into the firebox are also utilized to increase the steaming capacity. For illustration, let us employ the sectional view of a locomotive boiler. The boiler is of the usual construction, with firebox, door for feeding fuel, grate bars and tubes, as placed in ordinary practice. In the firebox, arranged parallel to each other, are an upper and lower series of water protected air tubes, extending

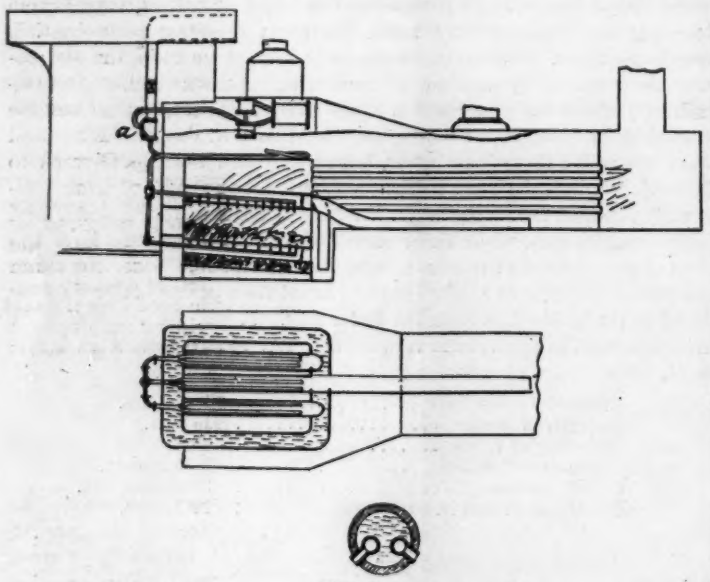


Fig. 2.

from the tube sheet to above and below the door. As shown in the detail, they are practically three tubes combined in one. The smaller tubes are inside the larger one, and extend nearly the length of the firebox. They are secured within the larger tube by a series of plugs or nipples, about 2 inches apart. These plugs are first driven through perforations in the tubes, and there bored out, thus forming a passage for the delivery of air, at the same time securing rigidly together the three tubes. The center tube of the upper series will be noticed to extend forward nearly to the forward tube sheet, resting on the bottom shell of the boiler. This continuation conveys the cooler water immediately from the front, to and through the water jacket of the tube with which it is connected, quickly heating the same and enabling the boiler to rapidly generate steam. If desired, the ashpan may be entirely closed, and air furnished by the lower series of air pipes, which are directly in the bed of fuel, and thereby preventing the red-hot coals from dropping along the roadway. In the top of the cab is seen a chamber, opening at the front end to the atmosphere. Connecting this chamber with the air system is an automatic valve, *a*, which cuts off connection between the chamber and system when air is being fed from the reservoir. The reservoir, suitably placed, is supplied with an air pump, and is also connected with the system at the automatic valve. Over the firebox is a coil of pipe, passing through which the air is heated on its way to the firebox. A serious objection to locomotives equipped with air-feeding mechanism is that when the locomotive is at a standstill the air supply ceases. In this case the objection is claimed to be obviated for the reason that the air pump and reservoir can be thrown into action when the engine is not moving.

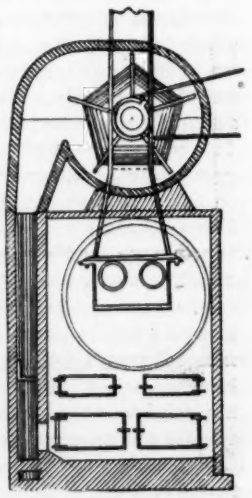


Fig. 3.

The third system is again quite different from the others. The above sketch shows the boiler with stack and ashpit doors. On top of the boiler and in rear of the stack is a fan, connected to the stack by a duct or neck. The smoke and gases are drawn into the fan and forced down the side pipe into the ashpit. There is a door in the duct between the stack and fan, through which the supply of air is admitted. There is also a damper in this duct, by closing which and opening the ashpit doors, the boiler may be run under natural draught.

The last system we will mention is one that has been tried here in Philadelphia. This invention supplied the furnace (by aid of two vacuum boxes and four pipes opening into the furnace above the burning fuel through which pipes were introduced) steam and heated air with great force, that mingled with the heated gases from the fire bed, and supplied the necessary oxygen for consuming said gases and promoting perfect combustion. Experiment had shown them that they obtained the best results by injecting combined steam and air, close to and in a horizontal plane over the burning fuel. By the use of *cold* air, the current supplied was at a normal temperature when it came in contact with steam, before the two were combined and injected into the furnace, with the result that the temperature of the steam and gases was greatly lowered; consequently the combined volume of steam and air, when entering the furnace, was not at so high a temperature as it should be to effectually mingle with and ignite the gases. The necessity was thus demonstrated of using *hot* air, as the rising products of combustion would only ignite at a very high temperature. The air was heated, before entering the furnace, by a series of pipes containing auxiliary hot air vacuum chambers beneath the grate bars. This arrangement was tested here some years ago in the *Record* building. The results of the test were as follows:

	Day Run.				Night Run.			
	With Attachment.		Without Attachment.		With Attachment.		Without Attachment.	
	Boiler 1.	Boiler 2.	Boiler 1.	Boiler 2.	Boiler 1.	Boiler 2.	Boiler 1	Boiler 2.
Coal used, lbs..	840	840	1,260	1,260	1,122	1,176	1,680	1,680
Av'ge steam pressure.....	64	64	55—60	55—60	63½	—	57-3/16	—
Ashes, lbs.	111	106	253	268	152	147	266	260
Water gauge....	2½	2½	2½	2½	2½	2½	2½	2½
Total coal used, with attachm't.	1,680 lbs.				2,298 lbs.			
Saving in favor of attachment..	840 lbs., or 33⅓ per cent.				1,062 lbs., or 31⅔ per cent.			

Two boilers, 80-horse power e ch, running a Corliss engine. Length of boilers, 12 feet; diameter, 40 inches. Twenty-eight 4 inch tubes. Fire space, 42 x 60 inches. Firebox, from she t of boilers to grate, 18 inches.

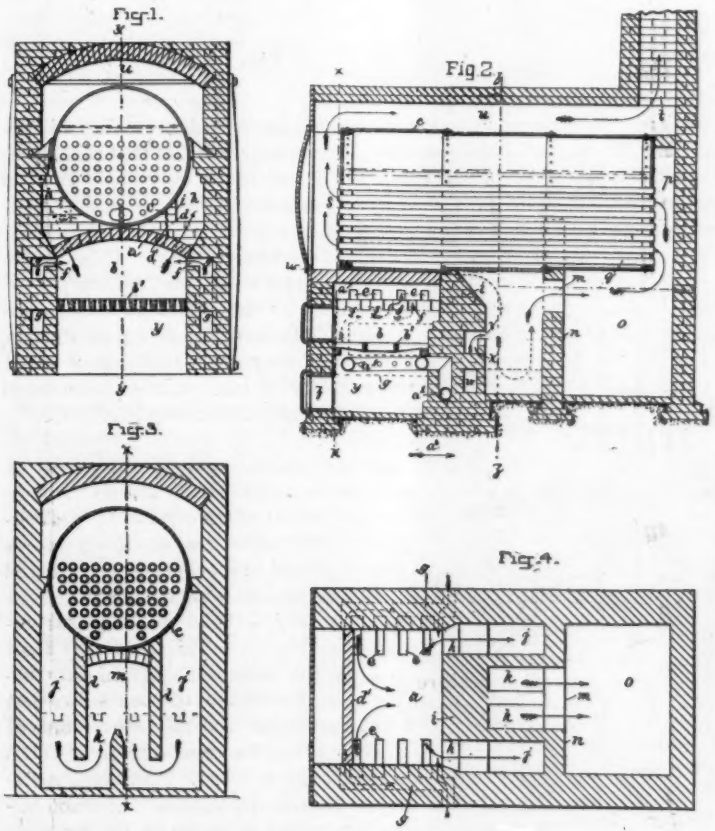
The four systems here described will suffice to illustrate how totally different are the ideas of their respective inventors as regards the means to be employed in reaching the same end. Briefly summed up they are as follows: The first supplies air under pressure; the second supplies heated air in a manner totally different from the first; the third essays to pass the smoke and gases through the furnace a second time; and the fourth supplies hot air and steam. Whatever be our opinions of the relative merits of these systems, they will afford us ample opportunity for discussion.

The Bates Smokeless Boiler Setting.

On May 8, 1894, U. S. Letters Patent (No. 519,658) were granted to Mr. John W. Bates, of Hoboken, N. J., for improvements in smokeless boiler settings. Using the words of the specification :

My invention consists in improvements in boiler furnaces designed to facilitate the supply and due admixture of superheated oxygen and steam with the combustible elements of the coal, and for more effective combustion of the combined elements for producing greater heat in the combustion chamber, and less waste by the escape of unconsumed portions of the elements, and at the same time to improve the construction of the arch, all as hereinafter fully described, reference being made to the accompanying drawings, in which—

Figure 1 is a transverse sectional elevation of my improved boiler furnace, taken on line $x\,x$, Fig. 2, with part of the wall separating the regenerative chamber from the escape passage at the front of the boiler broken out. Fig. 2 is a central longitudinal sectional elevation through



the furnace and boiler on line $y\,y$, Fig. 1. Fig. 3 is a transverse sectional elevation on line $z\,z$, Fig. 2, as seen looking in the direction indicated by arrow a^2, Fig. 2. Fig. 4 is a horizontal section on line $w\,w$, Fig. 2.

I provide an arch a, in the furnace chamber b, directly under the part of the boiler c, exposed to the heat of the furnace to protect the part of the shell of the boiler that would otherwise be exposed to the direct action of the heat, and to provide regenerative combustion chambers d, above the arch and under the sides of the boiler to which the gases ascend through a line of passages e, along each base of the arch, so as not to impinge directly against the boiler and directly under the arch and in close proximity to passage e are inlets f, for fresh superheated oxygen to mix directly and uniformly with the entire volume of gaseous products of the coal entering the chambers d, for regenerative effect therein, the air being conducted to said inlets f, along passages g, in the side walls of the furnace to be heated. Besides the better protection of the boiler from excessive heat afforded by the passages through the arch located along the bases of the arch, the fresh air entering through the sides is brought more directly into the gases than when the passages through the arch are distributed throughout its area, and another essential advantage is, the arch is much simpler to make and withstands the effects of the heat better.

At h are outlets in the bridge wall i, at the inner ends of the regenerative chambers through which the gases pass into a secondary combustion chamber behind the furnace, consisting of three divisions, j, j and k, separated vertically for the most part of the depth of the chamber by the partition l, causing downward flow of the gases in divisions j, and upward flow in division k, from which the gases escape through passage m, in another bridge wall n, into still another chamber of larger dimensions, where, under the rear end of the boiler, the hot gases are delayed to have greater heating effect on the boiler than if caused to escape rapidly through a contrated passage. The wall d^1 separates the regenerative chamber d from escape passage s. From chamber o there is a passage p, with which the tubes q communicate for the escape of the hot gases through them in the usual way to the escape passage s, at the front end of the boiler, and thence to the chimney t, in any approved way, as along the flue u, over the boiler. The secondary combustion chamber j, j and k is also supplied with fresh oxygen for further regenerative effect, this air being introduced through inlets v, in the back of the bridge wall for being heated in advance of entering the chamber. Air may be admitted to the ashpit y through the doorway z in the usual manner when material draft is sufficient, but for stronger draft it may be forced in through a pipe a^1, which may traverse the sides of the chamber under the fire grate b^1, and distribute the air through small perforations e^1, at intervals along the pipe.

Besides the protection of the boiler plate by the arch interposed between the primary chamber and the boiler shell above, more efficient combustion is attained in the first instance because fire is not exposed to the chilling effect of the low temperature of the boiler, the gases entering the regenerative chambers d are therefore of much higher temperature and more capable of effective combustion in exposure to the chilling effect of the boiler, and higher temperature will likewise result in the secondary chamber where the regenerative action will also be more effective, and the gaseous products of combustion entering the heating chamber o will consequently be more effective.

My contrivance of the arch intermediate of the fire and the boiler is distinguished from other arches thus located by the arrangement of the passages through it along the bases of the arch, as above set forth. I claim—

1. In a boiler furnace the combination of the primary furnace chamber, the arch intermediate of the said chamber, and the part of the boiler over said chamber, the regenerative chamber above the arch, a line of passages thereto along each base of the arch, fresh air inlets in the side walls of the furnace under the arch and adapted to supply air directly to the volumes of gases entering the regenerative chamber through said passages, the passages through the bridge wall, above the arch, from the regenerative chambers, and the secondary chamber having the longitudinal down draft divisions receiving the gases at the top, and the longitudinal middle division receiving the gases at the bottom, substantially as described.

2. In a boiler furnace, the combination of the primary furnace and the secondary furnace behind the bridge wall, both having direct action on the boiler and said secondary furnace, consisting of two longitudinal down draft divisions receiving the products of primary combustion atop, and the intermediate longitudinal up-draft division receiving the said products from the other divisions below and discharging them from the top, and the fresh air inlets in the back of the bridge wall to said secondary combustion chamber, substantially as described.

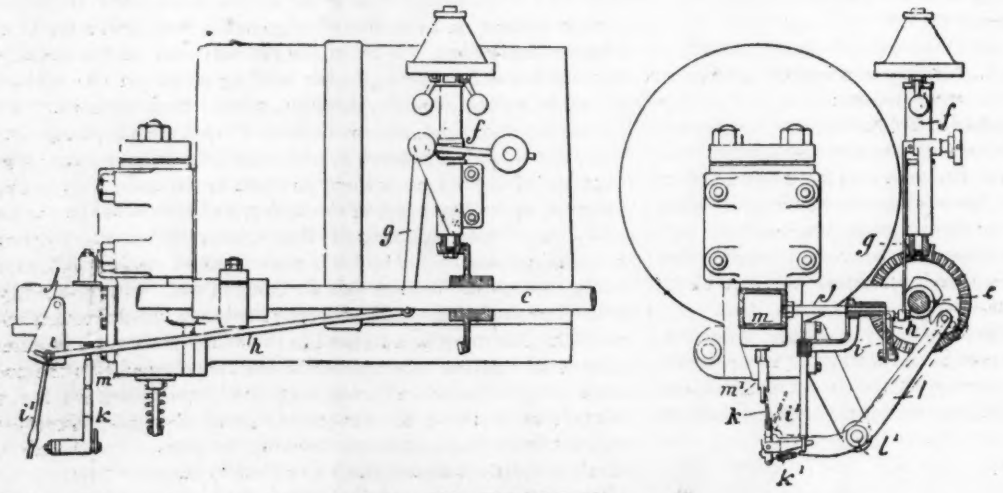
3. In a boiler furnace the combination of the primary furnace chamber, the arch intermediate to said chamber and the part of the boiler over said chamber, the regenerative chamber above the arch, passages thereto through the arch, fresh air inlets supplying air to the gases entering the regenerative chamber through said passages in the arch, and the secondary combustion chamber behind the bridge wall, consisting of the two down draft divisions receiving the products of primary combustion atop, and the intermediate up draft division receiving the said products from the other division below and discharging them atop, and the fresh air inlets in the back of the bridge wall to said secondary combustion chamber, substantially as described.

[Translated from *Revue Industrielle* by Mr. Herman Poole.]

The Andrew Gas Engines.

Two types of gas engines, called in France, very modestly, "Le Triomphe," and built in England by Messrs. Andrew & Co., are designed, the one for ordinary applications in wihich regularity of speed is not an absolute necessity, the other being designed more especially for installations of electric light, where uniformity of speed must be considered above all else.

The engines are of the four-course type, with distribution by valves and lighting by an incandescent tube. The first kind carries an inertia governor, and the second is furnished with a ball governor, the function of which will be explained by the aid of the accompanying illustrations. The regulator is moved by the lateral shaft of distribution e, by means of conical gearing. In the throat of its tube f pass the branches of a fork supported on a little axis which turns in the support.



Figs. 1 and 2.—Governor, etc.

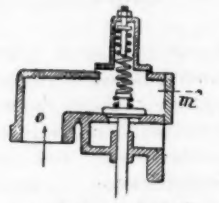


Fig. 3.—Safety Valve.

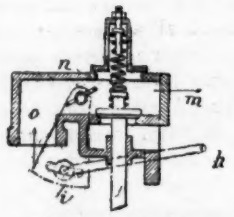


Fig. 4.—Safety Valve.

This axis carries on one side a counterpoise and on the other a lever *g*, which, by means of the rod *h* is joined to the sector *i*, turning around on a little shaft *j*. This is supported by the frame of the engine and fixed to the box of the valves for admission of gas *m*, filled by the conduit *o*, and governed by a spring (Fig. 3). The sector *i* forms, with an arm at right angles, an arrangement (Fig. 2) oscillating on the fixed point *j;* to the horizontal arm of the right angle is screwed a rod i^2, movable in a vertical plane and having a shoulder at its end so as to form a third part, which acts on a mechanism serving to regulate the speed of the engine by the suppression or arrival of the explosive mixture.

The essential portion of the mechanism is a rod *k*, articulated to the balance arm *l*, which turns around the fixed pivot l^1, and derives its motion from the action of a cam, supported on the lateral shaft *e*. A little spring k^1, interposed between the lower extremity *k* and the balance arm *l*, tends to always keep the former in such a position that the vertical arm determines the seizing of the notched head *m*, mounted on the rod of the gas admission valve. Under these conditions, when the speed of the engine increases, the tube *f* of the governor displaces the oscillating lever i^1, by the transmission through *g*, *h*, *i*, in such a way as to tend towards the horizontal arm *k*. There results that, at the moment when the cam of the shaft *e* acts on its lever *l*, this arm is seized by the shoulder placed at the end of the rod *i*, and forced to pivot around its articulation, which draws its arm into the oblique position indicated by the dotted lines, and prevents the notched head m^1 from acting. The admission valve *m* for the gas remains closed and the machine makes a revolution without explosion.

Regulation by total suppression of the gas is the one most ordinarily employed. Many builders are obliged to attempt making it efficacious and to remedy the effect quickly; moreover, if a certain number of revolutions occur without explosion, the walls of the cylinder may get cold enough to cause slow combustion and, perhaps, non-combustion. With a view of palliating these inconveniences, the builders of the "Triomphe" have combined the arrangements so that regulation by total suppression of the gas shall be produced only in those cases where regulation by partial suppression is insufficient to establish the proper speed. To do this the supply of gas to the engine is controlled by a valve, placed under direct control of the regulator. This system of partial regulating has been employed before only by engines of successive explosions. It has the objection that in presence of very great variation of speed the quantity of gas admitted becomes so small that the mixture may be imperfectly explosive.

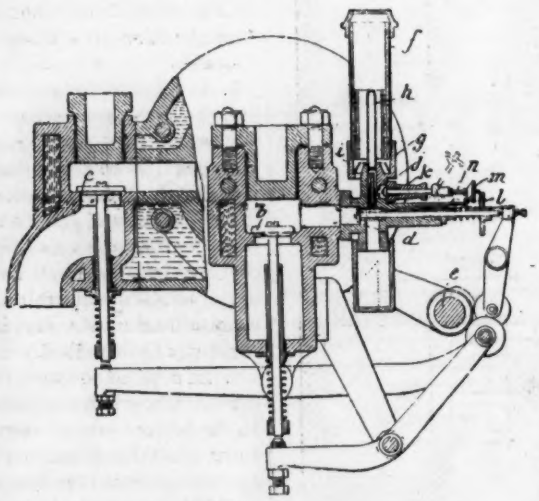


Fig. 5.—Lighting and Starting Mechanism.

In the present case, if the excess of speed is not sufficiently strong to cause the escapement of the click *k*, by the regulator, this acts no less on a little gate *n* (Fig. 4), placed in the pipe *o*, and fastened on an axis which is then substituted for the fixed rod *j* in the arrangement represented in Fig. 2. This axis may then turn on the supports conveniently arranged in the walls of the box *m*, so that it will participate in all the movements of oscillation that the regulator gives to the sector *i*, as seen above. The speed variations which do not involve the immobility of the valve *m*, cause in this way the greater or less diminution of flow of gas.

Lighting.—The mechanism of lighting is arranged in such manner as to allow the replacement of the incandescent tube, which becomes rapidly used up, without the necessity of unseating the valves which lead to it. It offers also a means of starting the engine without moving the flywheel. In the transverse section (Fig. 5), showing the distribution in this engine, *b* is the valve for the admission of the explosive mixture, *c* the valve for the escape of the burnt gases, and *d* that which determines the lighting. They are all actuated by levers moved by cams attached to the lateral shaft, *e*.

In the chimney *f* we see the incandescent tube *h*, at the bottom of which is situated the Bunsen burner *g*, and a centraltu be *i*, communicating with a little chamber *j*, provided

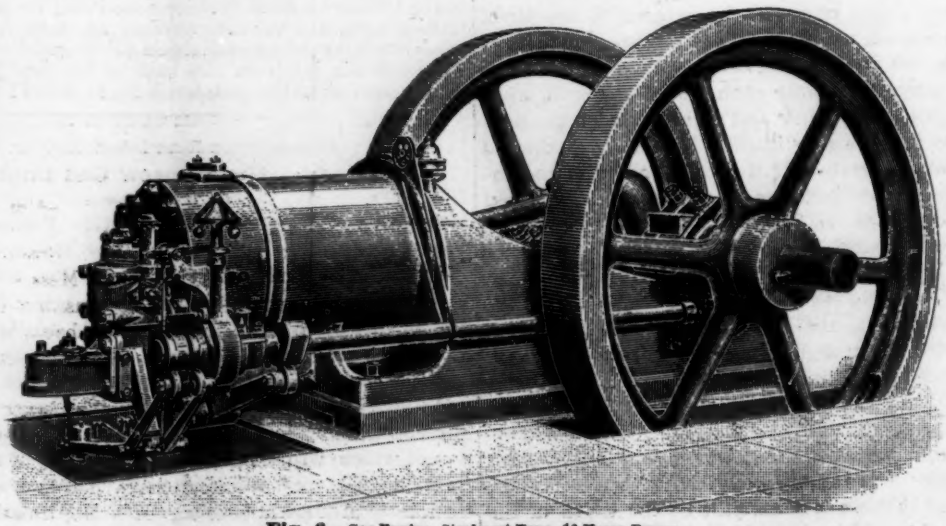
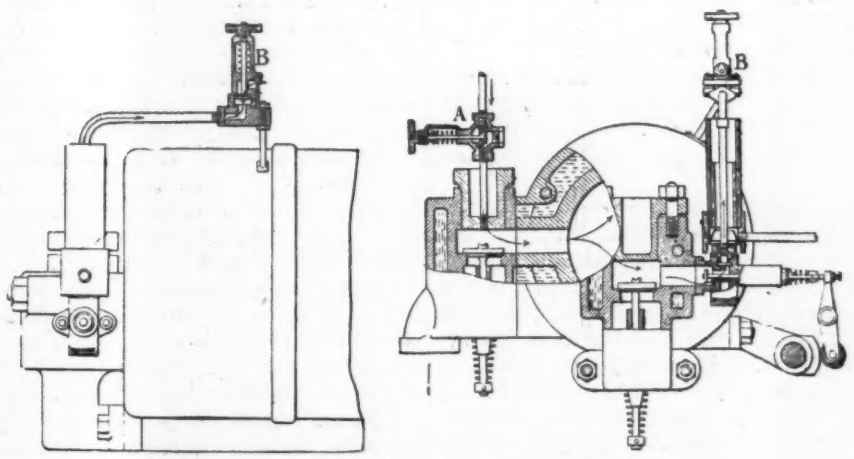


Fig. 6.—Gas Engine, Stockport Type, 18 Horse Power.

with a click valve *k*, which in opening puts this chamber in connection with a rear cavity having an opening in free connection with the outside air. This click valve *k* should open at the same instant, or nearly so, that the valve for lighting, *d*, does; in order to do this the shaft of this last carries a disk *l*, which just touches the arm *m* fastened to the end of the shaft of the disk *d*. When the disk *d* has been moved a convenient distance, the conical head of the arm *m* meets a shoulder *n*, which raises it, causes the arm to turn on its fastening, and disengages it from the detent *l*; at this instant the click valve *k* is allowed to close.

The machine is put in motion by the following method. When it was stopped care was taken to have the head of the connecting rod in the position corresponding to that of the piston in lighting. When the tube *h* is raised to incandescence by its Bunsen burner, which is fed by a pipe not shown in the figure, we open a little special valve, which admits the gas to the cylinder under pressure, and which is kept open by a spring. On entering the cylinder under pressure the gas drives out an equal volume of air, which fills the explosion chamber at the normal atmospheric pressure. This air goes through the valve *D*, open by reason of the position of its cam, passes into the short lighting tube *i*, runs into the incandescent tube *h*, and, by means of the chamber *j*, reaches the rear cavity of the disk *d*, likewise open, from which it escapes to the open air.



Figs. 7 and 8.—Starting Mechanism, Second Type of Messrs. Andrew & Co.

When the explosive mixture reaches the proper proportion for an explosion, it becomes ignited and the pressure of the deflagration causes the immediate closing of the click valve *k*, as well as that of the special valve of admission for the illuminating gas. The normal action of the distribution then becomes established automatically.

This click valve may remain working continually if judged advisable. In this case it opens at the same time as the valve for lighting, and allows a certain proportion of the products of combustion to escape into the air.

After starting the machine we may unfasten the disk *n* of this valve and place it in the position indicated by the dotted lines. Fig. 6 shows an engine of the Stockport type, to which the arrangement described above applies in the position given by the regulator. It is 16-horse power, nominal, but can develop 42-horse power indicated, or 33-horse power effective.

In the type "Triomphe" for electric light illumination, the arrangement employed is a modification of the system just described. The lighting tube is similarly raised to incandescence by a Bunsen burner, but it carries, as a prolongation of its superior extremity, a conduit which is joined by a curved tube to a box at valve *B*, and supported by the engine cylinder. A spring regulated by a screw passes into this valve, and tends to keep it always open.

On the other side we see in *A*, below the valve of escapement, another little valve box, with arrangements similar to those employed in *B*.

Under these conditions the starting is made as follows: By the auxiliary valve *a* we pass the gas under pressure into the cylinder, which draws out a corresponding volume of air from the cylinder through the lighting tube and its valve, which is open because of the position of its cam at the time the engine was stopped. This air arrives after a while at the box of valve *b*, which allows it to escape. As in the first case, when the mixture becomes explosive, its inflammation is caused by the lighting tube previously heated to incandescence, and at the same time the valves *a* and *b* close automatically under the influence of the pressure developed.

To cause the operation to become automatic at this time, it is sufficient to open the gas supply to the engine to establish its flow into the feed pipe.

It may be in order to mention a patented arrangement of Messrs. Andrew & Co. (Fig. 9) for preventing accidents due to freezing of the water surrounding the cylinders.

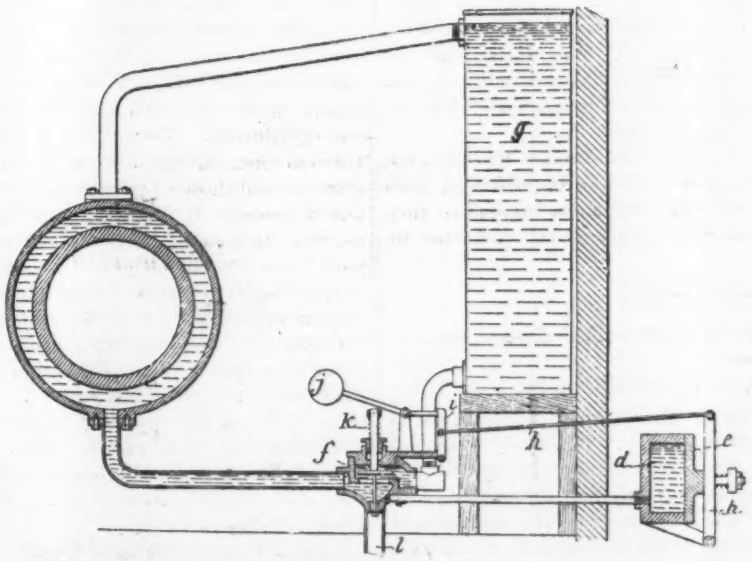


Fig. 9.—Apparatus for Protection Against Freezing of the Water Surrounding Gas Engines.

At the end of the return pipe to the water circulating reservoir *g*, a pipe is fixed which carries a safety box *d* outside of the building, of which the cover *e* is closed by a spring which gives in case of freezing of the water. This cover can also be made so thin as to break with the pressure caused by such coagulation. In the simplified arrangement of this apparatus care must be taken to keep closed during the night, and during long stoppages of working, the cock *f*, which governs the return to the reservoir *g*, so as to prevent complete emptying of the reservoir in case the cover *e* warps or breaks, which would also cause the emptying of the cylinder envelope.

For fear that this closing of the cock *f* might be forgotten, the constructors have made an automatic arrangement which produces the same result in case of freezing. For this the cover *e* displaces by its rupture a lever *h*, which, by means of its rod *h*, disengages by the hook balance *i* a weighted lever *j*, which drives, spite of its spring, the plunger *k* of the valve *f*, till it rests in its seat. The communication with the water reservoir is then closed, while by the same action of descent in this valve the little valve placed under it opens the outlet *l*, which permits the water of the cylinder envelope to run out.

Coal Mining in Illinois.

The 12th Annual Report of the Coal Statistics of Illinois, which has just been published by the State Bureau of Labor Statistics for the year ended July 1, 1893, is a very interesting document. The output was the largest ever reported for that State, showing an increase of more than 2,000,000 tons over the previous year. Among the most important items of information are those concerning the working of the gross weight law, the payment of wages, the location, number and rules regarding truck stores, the number of men working above and below ground, the cost of mining material, and other facts bearing directly on the production of coal.

The report shows that coal was mined during the year in 56 counties from 788 openings. The total number of net tons mined was 19,949,564,

of which 16,112,899 was lump coal, and 3,838,665 other grades. The number of acres worked out was 3,109, and the total number of employees was 35,390, of whom 26,145 were miners. The remaining 9,245 include boys, of whom 854 boys over 14 years of age worked under ground and 3,806 above. The average number of days of active operations at mines was 229.4.

The aggregate home value of the total product was $17,827,595, the average value per ton at the mines being $1.025 for lump and $0.5427 for other grades. The average price per ton for hand mining was $0.7145, being $0.6734 for summer and $0.722 for winter. The number of tons of lump coal mined by hand was 8,146,646, of which 1,775,211 tons were paid for by the day and 5,961,289 tons paid for by gross weight. The number of tons mined by machines was 4,729,749. The number of kegs of powder used, 353,772.

During the year 69 men were killed, making 32 women widows and 103 children fatherless. There were 403 men injured so as to lose time. This shows that 289,124 tons of coal were mined for each life lost, and 40,502 tons for each man injured. The number of lives lost was 1 in every 513 employees, and 1 man in every 88 was injured.

Seventy new mines were opened and 120 closed or abandoned. There has been a marked decrease in the number of mining places during the last four years, with a distinct gain in the output. This year shows a decrease in the number of mines of 51, although the product increases 2,087,288 tons.

Notwithstanding the number of mining places is 148 less than in 1890, the output of coal is over 4,500,000 tons in excess of that year, and seems to point conclusively to the abandonment of smaller mines as unprofitable, and to the concentration of the business to the larger and improved class of plants. The average value of lump coal, $1.03 per ton, is a trifle below that of the year previous, and the price paid for hand mining, computed on screened tons, 71.45 cents, is practically on a level with that of the year previous. The number of employees has increased 1,758, and the number of days of active operation was greater than any year for the decade. The mining of coal by machines is rapidly increasing, the number of machines employed being 10 more than last year, and the increase in tonnage as mined 836,460. While the number of men killed exceeds that of any other year, with the exception of 1883, the actual ratio of the fatalities to the number of employees and the number of tons mined is smaller than any year except 1886. The year of 1893 was one of marked activity and unusual prosperity in the coal industry, and these figures will be of great interest as a basis of comparison when the record for the troublous year of 1894 shall be made up.

The report shows that 38 truck stores are yet maintained by companies or firms operating coal mines. These are located in four districts, there being none in the fourth district. Several companies compelled their employees to take out accident insurance policies, and deducted the premium from their wages.

The Achievements and Aims of Physical Chemistry.

By Mr. J. E. Trevor, of Cornell University.

Chemical changes, in common with all other natural processes, are in their ultimate nature transformations of energy. The study of chemical processes is therefore a study of the energy phenomena which they involve. Chemical reactions may absorb or take up heat, changes of density may occur whereby work is done, electrical energy and radiant energy may be produced. But the mutual relations of heat, work, electricity and the like, involving the characteristic factors, temperature, pressure, tension, force, potential, etc., form the subject matter of the science of physics, and hence it is that the study of chemical processes as such has come to be known as the ***Physical Chemistry***. The object of this branch of science is to discover the simple relations connecting the various types of chemical phenomena, and to make of these relations a coherent whole.

The physical chemistry is a new science. Up to eight years ago nothing serious had been attempted in the way of generalization. Very important discoveries had been made before that time, it is true, yet they were of a wholly disconnected character and their bearing upon a general theory of chemical processes was not seen. Prominent among these achievements of a generation whose efforts have now become history stand the experimental work of Thomsen and Berthelot in thermochemistry, the investigations of Kopp in stoichiometry, the dissociation theory of Horstmann and of Gibbs, the brilliant researches of Helmholtz in electro-chemistry, and that flash of insight which led to the discovery of the law of mass action. Nor is the present generation proving itself unworthy of this inheritance of scientific achievement; the chemical equilibrium, the electro-chemistry, and the thermo-dynamical generalizations of to-day are supplying a fit sequel to this story of the past.

In 1886 appeared van't Hoff's first paper upon the theory of solutions. It was immediately followed by that extended series of monographs, written by such men as Ostwald, Nernst, Arrhenius, Planck, Riecke, and many others, which has made the thermodynamical theory of solutions one of the most remarkable conquests of the science of chemistry. Van't Hoff's discovery that the inner energy of a dissolved substance when dilute is independent of the volume of its solution led at once to the discovery of simple relations between the physical properties of solutions and their molecular concentrations, *i. e.*, to a series of novel methods for the determination of molecular weights; it brought about an unforeseen extension of the law of mass action to the solution-equilibria of both homogeneous and heterogeneous systems; it led to a strict formulation of the influence of temperature upon chemical equilibrium and the velocities of reactions, to a mathematical theory of hydrodiffusion, to a comprehensive theory of concentration currents and of the voltaic cell, and to an unexpected culmination of Ostwald's exhaustive investigations upon the chemical affinities of aqueous acids and bases. This breathless succession of advances constitutes one of the most interesting and exciting chapters of the history of chemical theory.

It is being succeeded at the present time by work of a more general and wide-reaching character. The great generalizations of thermodynamics are hastening the day when chemistry shall become a deductive science. Planck, of Berlin, has recently directed especial attention to the following course of reasoning.

There are certain processes, such as the conduction of heat from a hot to a cold body, or the diffusion of a dissolved substance from a high concentration to a lower one, which are irreversible—they take place only in one direction. This fact may be shown to require the conclusion that the trend of natural processes is in an assignable direction; the general state of things tends all one way. If this were not so it would be possible to reverse history, to make trees grow down into seeds and to awaken fossils to quivering, pulsating life.

The strict formulation which represents this general tendency furnishes, therefore, a means of determining definitely the direction which any given natural process, chemical or otherwise, must pursue; and it leads in consequence to an exact relation between the energy factors upon which the final state of the material system concerned is made to depend, a relation which combines in one expression every law of chemical equilibrium. From it can be derived in order all the laws of isothermal chemical equilibrium in homogeneous and in heterogeneous systems, and those which represent the effect of changes of temperature and of pressure in displacing such equilibria; it yields further the laws relating to the many physico-chemical properties of solutions which depend upon the vapor pressures; and it furnishes, finally, the almost numberless theorems of electro-chemistry. Thus it is seen that from the assumption of a simple fact of experience, the irreversibility of heat conduction, a mathematical theory of chemical changes is obtained which organizes into a coherent and logically connected whole all the exact relations of chemical science. The deductive value of this theory is enormous, in that it clearly points out the limits of our knowledge in every direction. And for the reason that the system is uniform and falls into a logical order it becomes of the greatest service in aiding the conception of chemical theory as a whole and in fixing in the mind the relations between its parts.

Another form of the same fundamental idea has been employed by the eminent French mathematical physicist, Duhem, in developing a systematic treatment of the theory of chemistry. From the properties of his ***thermodynamical potential*** (taken from the thermodynamical studies of Willard Gibbs) he has evolved an orderly discussion of the theory of dissociation, the continuity of the liquid and gaseous states, and the general theory of the chemical and physical equilibria of fluid mixtures, all of which is characterized throughout by strict uniformity of method and an unusual elegance of mathematical style.

These two methods of research are essentially identical, for they are based upon the same principle, and they both refer the solution of every problem to the properties of a single function of quantities which fix the state of the system concerned. In this respect they mark a distinct advance in the study of the science of chemistry.

The eminent fruitfulness of these thermodynamical methods has led to a fuller appreciation of the bearing and significance of the great energy generalization which they involve, and upon which, indeed, the entire framework of modern physical science really rests. If chemistry be in its ultimate nature an energy science, chemists obviously must study those energy transformations which constitute its phenomena. In

a chemical change different energies come into play, and the change continues until they hold one another exactly in balance. This balance determines, therefore, what the final state of the system in question shall be. Two energy forms are in equilibrium when a possible variation of one is exactly compensated by the corresponding variation of the other. All that is necessary then to determine the final state which any given material system must assume is to represent mathematically the possible variations of its opposed energies and to set these variations equal. This procedure is identical with that which is employed in statics to investigate the equilibria of mechanical systems. When applied systematically to the different types of chemical action it yields a rational classification of chemical processes, and, in a logical sequence, all of the known elements of the modern physical chemistry. This reconstruction of theoretical chemistry upon the basis of the energy theory is one of the most brilliant of Ostwald's many splendid contributions to science.

It is important to observe that the great advances of recent years in the theory of chemical action have not been made with the aid of the kinetic-molecular hypothesis. The assumption of atoms and molecules has been a constant hindrance to the progress of rational chemical theory. The "Kinetic Theory of Gases" has been able to account for the behavior of gases only in an imperfect manner, and it has not been able to account at all for the laws of chemical equilibrium and the properties of solutions. The fact that gases react in simple volume relations justifies the selection of a definite volume as the chemical unit, the relative weight of this volume becoming then the so-called molecular weight, but it justifies in no wise the conclusion that gases are composed of discrete particles. This unwarranted assumption was made because of a desire to "explain" from the behavior of a purely mechanical system the observed characteristics of gases. Yet the behavior of the model is, after all, only approximately that of the gas. And, moreover, it is not the province of science to "explain" anything, certainly not to explain phenomena by reference to irrealizable mechanical constructions. It is becoming more and more clearly seen, day by day, that the business of science is to *describe* phenomena in a simple manner, to seek actual relations between measurable quantities, to deal only with things which can be handled and observed. Hypotheses must be employed, if at all, only provisionally and as analogies.

There is no desire to deny that the molecular hypothesis has been fruitful of results; any hypothesis may lead to work whereby knowledge is gained. Yet this one has nearly outlived its usefulness, and it will be employed less and less in the future by those chemists who refuse to believe upon insufficient evidence. As an accepted hypothesis its days are numbered. In the place of the molecule appears the molecular weight, a sharply defined quantity whose conception does not transcend experience.

The average student of chemistry is trained to confuse the real with the hypothetical. He believes molecular formula and molecules to involve each other, whereas the former represent facts while the latter are creations of fancy. The molecular formulas of our chemical equations possess a very real and important signification, and this is no less true of the structural formulas which form at the present time so important a feature of the technical apparatus of organic chemistry. These structural formulas are valuable mnemonic expressions for the individual chemical character of the substances in question, and when employed for what they represent, their value is not to be underestimated. Yet one must not for a moment suppose that they supply a picture of the mechanical structure of small particles of the substances; this idea is a purely hypothetical one, and at the best represents nothing more than the original facts. The symbols, properly used, represent the facts and not the hypothesis.

The general methods which give to the best modern thought its distinctive character appeal to experience alone. Things other than observable fact do not fall within their province, such things are not objects of human knowledge. It should not need emphasis that this is the only natural and reasonable basis for a science of the facts of nature. And it cannot be denied that our first real insight into the nature of chemical processes has been gained by the application of these straightforward methods.

The age of mechanical hypotheses is of the past. The desire to replace known laws by unproven or unprovable assumptions is passing away. And it can now be clearly recognized that the view which seeks to place mechanics at the base of all departments of physical science is, in its thoughtless exclusion of energies other than mechanical, a prejudice. Now, the thermo-dynamical systems and the energy doctrine involve only accessible facts. They are built upon no assumption other than the irreversibility of some spontaneous process, or the observed conservation of the energy of an isolated system. Their aim is to increase knowledge and not representations of knowledge, to seek out the facts of nature and the wonderful and simple relations subsisting among these facts. And in this there are notable instances of what is fittingly termed *Physical Theory*. The distinction between theory and hypothesis can now be sharply drawn, the hypothesis is a mechanical construction substituted by the imagination for things as they actually are, the theory is an organized system of logical consequences drawn from the established facts of experience. Mechanical hypotheses have dimmed the glory of the history of chemistry, physical theory endows chemistry with the attributes of an exact science.

The subject of electro-chemistry has become, in recent years, a prominent feature of the physical chemistry. The energy liberated in chemical changes may appear as electrical energy; or electrical energy may, during a chemical process, be transformed into the inner energy of the products of the reaction. Our knowledge of these things has had a contentious and a profoundly interesting history. The strugglings and gropings of a hundred years lie between this time and that in which the first observations of electro-chemical action were made by Galvani and Volta. The intervening years have been largely occupied by a study of the phenomena of electrolysis pure and simple. The insight thereby gained into the nature of this process has led to a clear conception of what takes place in the various types of voltaic cell, and has, in consequence, rendered accessible to immediate calculation all the essential details of the transformation between the free energy of the chemical action in a cell and the electrical energy which is produced. This comprehensive theory of electro-chemistry is one of the greatest results which has followed the introduction of the energy theory into chemistry, it is the fitting close of a century of effort.

And now that such a result has been reached it is a matter for congratulation that the event is to be marked by a great literary monument. This is Ostwald's work on electro-chemistry, at the present moment passing through the press, a book which is to give a full and clear account of the entire development of the subject from its beginnings.

The influence which has been exerted upon physical chemistry by its literature is of the most interesting character. Widespread interest in physical chemistry as an independent subject dates, probably, from the publication of Ostwald's *Lehrbuch der allgemeinen Chemie*, in 1887. The interest thus aroused was immediately intensified by the appearance of van't Hoff's thermodynamical theory of dilute solutions, and the remarkable series of theoretical and experimental discoveries which followed in its train. This period marks, undoubtedly, the beginning of physical chemistry as a connected and organized science. Its development since then, due to no small extent to the efforts of Ostwald and van't Hoff and their pupils, has found a fit channel for expression in the pages of the *Journal of Physical Chemistry* (*Zeitschrift fur physikalische Chemie*), whose first number appeared also in 1887. A systematic account of the present status of the science is now being supplied by a new edition of Ostwald's *Lehrbuch*, which has in the meantime grown to be a monumental work in three volumes, two of which are already in print. And it is well to add that the general desire for a text-book of less exhaustive nature has been well met by the briefer "*Outlines*" by the same author, and the "*Theoretical Chemistry*" of Nernst. Due reference has been already made to Ostwald's magnificent publication upon electro-chemistry.

The great demand now to be made upon the future is for a book upon the *General Theory of Energy*, a work in which the relations of natural phenomena to one another may be brought into a clear light, a work in which we may finally see effaced the artificial distinctions between the subjects of chemistry, mechanics, thermodynamics, electricity, etc., which, as we have them now, are partly historical, partly physiological, partly conventional, and wholly unsatisfactory.

The science of physical chemistry is, at the present moment, in a stage of the most active development. Every month brings to the light some startling experimental discovery, or some broader generalization. The general methods now in use have already begun to furnish a complete thermodynamical theory of solutions for all concentrations, a thorough grasp of the conditions of chemical equilibrium in complex heterogeneous systems, a really adequate comprehension of the phenomena of galvanic polarization, and an exact definition of chemical affinity. These are the things of to-day, what the morrow may bring forth is for no man to say. Yet it is certain that the chemistry of the future will deal with fact and not with fancy, and that its immediate aim will be the establishment of exact relations between those quantities upon which the state of every material system ultimately depends. For it is in this way, and in this way only, that a real insight into the nature of chemical processes will finally be attained.

The Manchester (England) Corporation Gas Works.

Engineering, in describing the gas works of the city of Manchester, England, says:

The gas works of the city of Manchester have been the property of the corporation since the year 1844, and have been successfully administered by that body for the benefit of the ratepayers.

At the present time there are comprised within the term gas works in Manchester, three works or manufacturing stations—the Gaythorn, the Rochdale road, and the Bradford road stations. Of these the Gaythorn station is the oldest, but the smallest. Its manufacturing capacity is four million cubic feet of gas per diem. The Rochdale road station has hitherto been the largest and principal city works, and is capable of manufacturing 8½ million feet each day. The Bradford road station is comparatively new. Its construction was commenced in the year 1877, but it was not utilized for gas making until 1884. The site of these works embraces an area of 52 acres of land, and when completely utilized will afford space for the production of 20 million cubic feet of gas per diem. Thus, while the older city works have long since reached the limit of their capacity, the Bradford road station is destined to exceed them in importance as it becomes further developed. At the present time this station is fully equipped for a daily make of 8 million cubic feet of gas.

As this station is the most recent in construction, and, consequently, the most modern in design amongst the Manchester gas works, it has been selected as the subject of a visit on the part of the Institution of Mechanical Engineers during the Manchester meeting. We therefore propose confining our attention chiefly to it. The works contain, at the present time, two large retort houses for the distillation of the coal and cannel from which the gas is produced. The two retort houses are built side by side, with a coal store between them, their ends abutting on the railway sidings where the coal is received. The sidings are in communication with a branch of the Lancashire and Yorkshire Railway, which bounds the works on one side. The retort houses are 360 ft. long by 70 ft. wide and 33 feet high to the springing of the roof. Each contains a retort bench, comprising 28 ovens, or "settings" of retorts, containing eight or nine retorts in each setting. The total number of retorts is 480. They are of arched section, 24 in. wide by 16 in. high and 20 ft. long. They are what are known as "through" retorts. The retort ovens or settings are all heated by the regenerator system. There are three chimney stacks in each retort house. Some of the furnaces are constructed on a plan designed by Sir William Siemens, but in the more recent settings a plan has been adopted which has been elaborated at Manchester with the assistance of the present Gas Engineer, Mr. G. E. Stevenson, M. Inst., C.E., and which is found to answer well.

In the later of the two retort houses, which was fitted up two years ago under Mr. Stevenson's superintendence, the drawing and charging of the retorts is performed by machinery worked by compressed air, made by the West Gas Improvement Company, Limited, of Miles Platting. The machinery consists of a drawing machine actuating a rake for discharging the coke from the retorts, and a charging machine carrying a coal hopper, from which a scoop is loaded and introduced into the retorts by the action of a pneumatic piston very similar to a hydraulic ram. The scoop enters the retort twice for each charge, and, revolving on its axis alternately to right and left, deposits the coal in an even layer on the floor of the retort. Each scoopful consists of 2 cwt. of coal or cannel, the complete charge being 4 cwt. For working the "through" retorts two sets of machines are necessary, one on either side of the retort bench. Each "through" retort receives two charges of 4 cwt. each, making a total weight of 8 cwt. charged into each retort. Five charges are introduced in 24 hours. The operation of drawing and charging each retort occupies on the average about one minute. The machines are capable of drawing and charging 20 ovens or settings, the retorts being divided into three sets, of which one set, numbering 60 retorts, is charged every hour and 40 minutes. As the "run" of the machines seldom occupies more than an hour, ample resting time is given for the machinists and other men employed in the operations. The reduction of labor effected by the use of stoking machinery at these works has resulted in important economy, the cost of carbonizing being at least 25 cents per ton of coal less than when hand labor was employed. Nor is this by any means the only advantage derived from the use of machinery, another important point being the rapidity and punctuality with which the operation is performed, thus enabling a larger quantity of coal to be carbonized within an equal period of time, and thereby increasing the productive capacity of the plant. Both the coal carbonized and the residual coke are moved mechanically. The coal is raised from the store into which it has been dropped from the railway wagons, by elevators, and delivered into fixed overhead hoppers, from whence the charging machines are replenished as required.

The coke, when drawn from the retorts, falls through shoots in the stage floor into tipping trucks running on a small railway underneath the stage. After the machines have finished their work, the train of trucks is drawn out and conveyed to the coke heap, where the trucks are emptied. Railway stages or gangways are erected at either side of the retort houses for the delivery of coal and cannel, and these, as well as the coal store between the houses, are in direct communication with the sidings.

Next to the retort houses in importance come the condensing, exhausting and washing apparatus. The condensers are of the water-tube type. Of these there are three of Morris & Cutler's patent horizontal water-tube condensers, each capable of condensing 1¾ million feet of gas a day, and one by Clapham Brothers, of vertical form, of a capacity of 3 million cubic feet a day. In these condensers the gas is brought into contact with a number of small tubes placed close together, through which cold water is allowed to flow. In this way the temperature of the gas is reduced and the condensation of the tarry vapors effected. The exhauster room contains two sets of Gwynne & Co.'s combined engines and duplicate exhausters, the engines being of the inverted vertical type, and the exhausters having a nominal capacity of 100,000 cubic feet of gas per hour.

There are also two other sets of horizontal engines and duplicate exhausters of a capacity of 80,000 cubic feet per hour each. This machinery, together with the various steam engines and pumps required for other purposes, is supplied with steam from four Lancashire boilers each 28 feet long by 7 feet in diameter, situated in a boiler house adjoining the exhauster room.

The washing machinery consists, firstly, of four Livesey washers to cleanse the gas from the remaining traces of tar, and to remove a proportion of the carbonic acid and sulphureted hydrogen present in the gas. This is effected by dividing the gas into minute streams and causing it to bubble through the ammoniacal liquor in the washers, the impurities becoming thereby fixed as carbonate and sulphide of ammonium. There are, secondly, three rotary "washer-scrubbers," two of which are Kirkham, Hulett & Chandler's "standard" washer-scrubbers, of a daily capacity of 2½ million feet each, and one Clapham & Laycock's "Eclipse" washer-scrubber, of 3 million feet capacity. In these vessels the ammonia is removed from the gas by contact with pure water. The final purification of the gas is effected in the purifying house. This is an iron building 300 feet long by 73 feet wide, and in it are erected 16 purifiers, each 33½ feet long by 26½ feet broad. The purifiers are divided into four groups of four boxes in each, and the gas passes through them in four separate streams, four purifiers only dealing with each stream. Oxide of iron is used for purification, and removes all traces of sulphide from the gas.

The station meters, together with the governors for regulating the pressure of gas in the town mains, are situated in a building on the plot of land on the further side of the railway, devoted to these and to the gasholders. There are three meters for measuring the production of gas, each capable of recording the passage of 150,000 cubic feet of gas per hour. In this building are also fixed two sets of engines and exhausters for exhausting the gas from the Rochdale road works, where the storage capacity is deficient, and delivering it into the gasholders at Bradford road. The gasholders at Bradford road are at present four in number, each 153 feet in diameter. They are telescopic, in three lifts, each lift being 33 feet deep. These holders have a total storage capacity of 7,000,000 cubic feet.

A gasholder of much larger dimensions is now being constructed, with the object of making good the deficiency at Rochdale road, as well as providing increased storage room at Bradford road. This gasholder, which, together with its tank, has been designed by Mr. Stevenson, will be 250 feet in diameter and have three lifts, each 50 feet deep. It will contain the same quantity of gas as the four existing holders, viz., 7,000,000 cubic feet. A departure is being made from the older style of construction in which cast iron columns were used to support the holder, inasmuch as the guide framing of the new holder will be of steel of comparatively light construction. It will rise to a height of 150 feet. The tank is 254 feet in diameter by 50 feet 6 inches deep. It will contain a timber framing to support the untrussed crown of the gasholder when not inflated. This framing will be carried on 196 pipe columns, 30 feet long by 10 feet in diameter, placed on brick pillars, and tied together by wrought iron tie-rods. The construction of this tank involves some 86,000 cubic yards of excavation, and will absorb 6,000,000 bricks, the greater part of which are being made on the premises of the clay obtained from the excavation. The advantage of

large gasholders from the point of view of economy in capital expenditure, is evident from the fact that whilst the four older gasholders cost, with their tanks, altogether $715,000, the contracts for the new tank and holder amount to $325,000 for an equal cubical storage capacity.

The Corporation of Manchester also own a small gas works in the township of Droylsden, capable of manufacturing 500,000 feet of gas a day. These works are made use of for the trial of new systems and methods in carbonization and purification, etc. Here may be seen at work the inclined retorts, a system which is intended to obviate the labor of lifting and depositing the coal in the retorts by the simple device of placing the retorts at an angle instead of in the horizontal position, and running the coal in at the top end by gravitation, the coke sliding out at the lower end by the same force of gravity. At this so-called experimental station there is also a gasholder in operation constructed without external guide framing, its vertical position being maintained by internal radial guides, on the principle introduced by Messrs. Gadd and Mason, of Manchester. The holder is made by Messrs. R. & J. Dempster, of Newton Heath.

The total manufacturing capacity of the Manchester Gas Works is now 21,000,000 cubic feet a day, and when the large gasholder referred to is completed their storage capacity will be 25,000,000 cubic feet. The maximum consumption of gas hitherto experienced in one day has been 22,000,000 cubic feet. The area covered by the supply of gas from the Corporation Gas Works is nearly 30,000 acres. There are 700 miles of main pipes, 80,000 meters in use, and 15,000 public lamps lighted by this department.

Electricity in Mining.

In a paper read by Mr. Chas. E. Bowron, before the Alabama Industrial and Scientific Society, the author held that of all the forces at command in the science of mining, electricity seems to be the most adaptable and more nearly fulfills most of the conditions demanded, viz.: Safety, efficiency, reliability, simplicity and flexibility on the one hand, on the other the economic necessity of a minimum of cost in application and production. Risks to life and property are very great in mining, and the dictates both of humanity and economy will be best subserved by the adoption of any agent which will tend to minimize these risks. The great ease of production and application in the first instance, then its great flexibility and efficiency give electricity a strong claim for our careful consideration.

Its competitive forces are steam, compressed air, hydraulic power and wire rope transmissions. As to hydraulic power, its application (except as a prime agent) is evidently so costly and limited, while wire rope transmissions beyond a comparatively short limit are entirely out of the question and cannot be used except for special purposes, that we may limit the discussion to steam, compressed air and electricity.

Considering the demands of a mining plant, we see power consumed in winding, outside and inside hauling, coal cutting, coal and rock drilling, pumping, ventilation, lighting, signaling and explosive firing. Regarding the prime source of energy for such power, it may be either hydraulic or steam power (leaving gas engines out of the question in their present state). In either case electricity comes to the front. In many cases the topographical surroundings and the location of fuel and water limit the location of a steam plant, which may have to be so far away as to be very inefficient, where the steam is to be used at the mines; with electricity we generate it at these same boilers, and placing them where they will suit the economic conditions of best service, convey the power to its work with but slight loss. These conditions very often obtain in the western mining states, the location of a steam plant perhaps being a matter of great mechanical difficulty in transportation and erection in the first place, and where the site of water for the boilers and the haulage of costly fuel prescribe the limits. With this agent, though, we erect our steam plant and dynamos at the most advantageous site and take the electric cable to the mines, elevation and distance no longer almost insuperable obstacles. An instance of this kind is the plant at the Virginius mine in Colorado, at an elevation of 12,000 feet. The cost of fuel there, which had to be packed up the mountain on "burros," was stated to be $18 per ton, amounting in a year to some $80,000. The present source of power is Red Canyon Creek, 4 miles distant from the openings, where 300-horse power are generated and carried to the mines at a pressure of 800 volts; the saving of fuel in one year alone paid for the electric plant.

Difficulties occur in mining in proportion to distance, and except for short distances, say up to 2 miles, neither steam nor compressed air can be considered dangerous rivals of electricity, on account of its high efficiency for long distance transmissions, the comparison growing the more favorable to the latter as the distance increases. We may use steam at the pit mouth for hoisting or running a fan and take it underground for a short distance for pumps, drills and rope-hauling engines, but when we wish to take it several miles away for drilling, coal cutting, etc., its use is entirely out of the question, unless another plant be erected, either undergroud, which is often objectionable, or at the expense of another surface plant and a shaft or bore hole to take the steam underground.

The efficiency of steam is low because dependent upon its retention of heat which is continually lost by radiation and condensation, no matter how well protected the pipes by covering, and it loses quickly also by friction and leakage. In the use of compressed air, there is a large initial loss of the heat of compression and as in the case of steam further large losses in friction and leakage. In the case of both steam and compressed air, the loss increases much more rapidly than the proportional increment in distance. Here is one of the strongest points of electricity, and it is the only power so far which meets what we may call the "distance emergency" in mining, from an economical standpoint. Here we have no losses analogous to the losses mentioned in the case of steam and compressed air to the extent that there prevail in their transmissions. When not at work, no power is consumed in electrical apparatus, the prime generator producing just what is consumed, automatically. At a Michigan mine, 175-horse power are transmitted three miles by compressed air, with an efficiency at the mines of only 35 per cent.—thus showing a 65 per cent. loss in transmission. With electricity, these figures would, beyond doubt, be reversed. One electric company guaranteed an efficiency of 73 per cent., based upon an initial efficiency of 100 and successive losses of 10 per cent. in dynamo conversion, 10 per cent. in line transmission, and 10 per cent. in reconversion at the motor. An ordinary efficiency of compressed air is from 20 to 40 per cent., rarely 50. The cost of conductors for carrying an equal amount of power at average pressures has been stated by Prof. M. C. Ihlseng, in the case of electricity, steam and compressed air, to be as 1 to 27 to 19.

An invaluable feature of an electrical mining plant is its great flexibility and the great ease with which changes in the distribution of energy can be made. It is but a few hours' job to branch and take a wire to any part of the mine to a motor, compared with an equal number of days to lay heavy, cumbersome and expensive pipe line for the same purpose. With greatest ease we lead a wire round a corner, take it up or down a shaft or slope, in and through places where it would be dangerous and difficult to lay a pipe line. Simplicity and completeness commend themselves at all times to the miner, and nothing can be more complete than the different ways in which we can harness electricity to our various uses in this direction. We may use it for lighting our tipple or breaker, hoisting the mineral, ventilating apparatus, inside and outside hauling, cutting, drilling, underground lighting, signaling by bell or telephone, and for explosive firing. It is also adapted to outside operations and is applied to them in such lines as crushing, stamping, jigging, concentrating, etc., and further along in metallurgical operations upon the mineral, such as the production of aluminum by the Cowles process.

The impediments in the way of the adoption of this agent in mining have been several. Mr. Pocock says: "Electrical engineers are not familiar with the routine of practical colliery workings and are, therefore, placed at a disadvantage by not knowing the actual requirements of mining engineers and the many little difficulties to be met with in underground workings; and until mining engineers have acquired the necessary knowledge and a confidence in electricity, it is only natural that they will continue to follow the beaten path. Experiments in mining are costly, necessarily, and until a method or applhance can hope to compete with the older way, it has to be brought to a "hard pan" basis, before it will receive the consideration due to its merits, however pronounced or enticing. While an electrical mining plant as a whole is comparatively simple, yet the details of the mechanism of the different machines, locomotives, etc., remain to be considerably simplified to withstand inevitable hard usage to which they will be subjected."

MR. H. R. MILLER, Manager of the Keokuk (Iowa) Gas Light and Coke Company, has been authorized by his Directors to enter into a contract with the United Gas Improvement Company for the installation of a standard set of the latter's improved Lowe water gas apparatus, rated to produce 100,000 cubic feet per day, the contractors also to furnish the accompanying auxiliary work. This plant is an addition to the Keokuk Company's coal gas plant, so that hereafter Manager Miller will have under his control a works full abreast of the times. The addition will be completed prior to Nov. 1.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. J. R. TODD, formerly in charge at Middletown, N. Y., assumed the Superintendency of the Dedham and Hyde Park (Mass.) Gas Light Company on the 1st. inst., succeeding Mr. George F. Goodno. Mr. Goodno resigned from Dedham to accept the management of the Cedar Rapids (Iowa) Gas Light Company.

WE regretfully report the death of Mr. Walter E. Hopper, whose demise occurred at his home in the Germantown district of Philadelphia, on the 2d inst. The funeral services were celebrated at Germantown on the afternoon of Augsust 4. Deceased, who was a son of the late Thomas C. Hopper, succeeded his father in the Board of Trustees of the American Meter Company.

THE authorities of Wakefield, Mass., are to be congratulated on having secured the services of Mr. Charles S. Spaulding to superintend the gas plant recently taken over by the residents of Wakefield under the State Act. He assumed charge on the 1st inst.

MRS. ELIZABETH H. ANDERSON has filed an action against the Salt Lake City Gas Company, the Salt Lake Power and Heating Company, the Salt Lake and Ogden Gas and Electric Light Company, and the Gas, Water and General Investment Trust (Limited), of London, in the Third District Court of Salt Lake. The plaintiff alleges in brief that she was the owner of 17 shares of the stock of the Salt Lake City Gas Company, and that the capital stock, franchises and plant of said Company were inadequately and without her consent transferred to the Salt Lake and Ogden Gas and Electric Light Company, thereby rendering her stock valueless. In view of these allegations she prays that the sale referred to be declared void, that the bonds and the trust deed of said property, franchises and plant, made by the Salt Lake and Ogden Gas and Electric Light Company, be declared void, unless said Company delivers to her shares of stock in the last-named Company which shall be the same proportion to the whole as her stock in the Salt Lake City Gas Company was to the whole of the stock in that Company. The defendants in answer deny all of the complaint, and further aver that they have at all times been willing to pay plaintiff the full value of her stock, or issue to her its equivalent in shares of the Salt Lake and Ogden Gas and Electric Light Company.

IN our last issue mention was made of a renewed attempt on the part of the Board of Supervisors of San Francisco to pass an ordinance reducing the rate ($2 per 1,000 cubic feet) charged for gas by the local Companies. After the initial discussion on the matter was had an adjournment was taken in order to permit Supervisor Hinton to present some statistics, which he claimed would prove that the $2 rate was exorbitant. At the renewed hearing Mr. Hinton's statistics were presented, and were followed by the presentation of other statistics, submitted by the San Francisco Company, which sought to prove that the rate was not only just but fair. When the discussion closed a motion to order the gas rate reduced to $1.85 was put and lost.

THE Alameda (Cal.) water works system (or rather the distribution system thereof) has been sadly disturbed through the effects of electrolysis. Two serious breaks have occurred, and Superintendent Brown urged the authorities to bring suit for damages against the Street Railway Company.

THE following notice explains itself: "The West Side Gas Company, of Kingston, Pa., has turned gas into its mains. The price will be $1.50 per 1,000 cubic feet, with a discount of 10 per cent. for prompt payment of bills. Parties desiring gas for light, heat or power will, for a limited time, have their services run and meters attached without charge by applying to the Company at its office in the West Side *Times* office, Market street near Wyoming avenue."

AT the annual meeting of the Lowell (Mass.) Gas Light Company the following officers were chosen: Directors, S. G. Mack, L. Sprague, J. Rogers, A. G. Cumnock, G. S. Motley, E. M. Tucke and Jas. Francis; Treasurer, Jacob Rogers; Clerk, E. B. Bartlett.

GENERAL JOURDAN, President of the Fulton-Municipal Gas Company, of Brooklyn, N. Y., in his role as chief canvasser for the Company, recently signed a contract with the Charities Commissioners, of Kings County, under which he agreed to supply gas to the Penitentiary, the Morgue and the Elm Place office of the Commissioners, at the rate of 90 cents per 1,000 cubic feet. Now, if he can only secure the lighting of the Raymond street jail and the Police Courts, his apostolic efforts in spreading the light on a Cheap-John basis would be complete. Perhaps he has those already on his list.

THE following is from the Minneapolis (Minn.) *Tribune* of the 1st inst.: "R. H. Pugh, who is said to represent Chicago capitalists, is having circulated for signatures a petition embracing the substance of an offer which he will submit, together with the petitions, to the City Council. The petition is:

"*To the Honorable Mayor and City Council of the City of Minneapolis:* Gentlemen—

"*Whereas*, the city of Minneapolis, having a population of over 200,000 inhabitants, has at present only one Gas Light Company (namely, the Minneapolis Gas Light Company); and

"*Whereas*, The mains and pipes of the Minneapolis Gas Light Company fail to reach a large number of the people of said city; and

"*Whereas*, The gas service even in these portions of the territory in said city reached by the present Company, is very unsatisfactory, owing to the very high prices charged by said Company for its gas; and

"*Whereas*, R. H. Pugh asks your honorable body for a franchise granting to him the right to build gas works, lay gas mains and supply gas in the city of Minneapolis, under which proposed franchise it is intended to furnish gas equal, if not superior, to the gas now furnished in said city, at prices not to exceed the following, viz.: Illuminating gas at $1.30, gross, per 1,000 cubic feet, or $1.10, net, for cash, within 15 days after the first of every month. Fuel gas at $1.10, gross, per 1,000 cubic feet, or 90 cents, net, for cash, within 15 days after the first of every month; and

Whereas, The average price offered above for gas is about 50 per cent. less than the prices now charged in the said city; and

"*Whereas*, Said R. H. Pugh offers and proposes to pay to the city of Minneapolis for said franchise 5 per centum of the gross receipts of all gas sold to private consumers in addition to its taxes; and

"*Whereas*, In order to promote the growth of the city and encourage manufacturers to locate here, and to enable them to compete with other cities, it is necessary to put Minneapolis on the same footing as neighboring cities, by giving her citizens cheap fuel and illuminating gas; now, therefore, we, the undersigned citizens of Minneapolis, do hereby respectfully petition your honorable body that the proposed ordinance, entitled, 'An ordinance granting to R. H. Pugh the right to lay gas pipes, etc., in the city of Minneapolis,' be favorably acted upon, and that he be granted the franchise asked for, subject to such restrictions as are deemed proper by your honorable body."

A CORRESPONDENT at Toronto, Can., writing to the JOURNAL under date of August 1st, says: "About 18 months ago, the Ottawa (Ont.) Gas Company received bids for the erection of a water gas apparatus. The competition among rival constructing companies was very keen, and finally resulted in the Ottawa people closing a contract with the Economical Gas Apparatus Construction Company, of Toronto, for one of their settings, on account of their guarantee to place gas in the holder at a less cost than any other Company. This caused one of the older Companies to assert that the Economical Company would make agreements which they could not fulfil. The works were completed and the result of a month's test showed that gas had been placed in the holder at a cost of four and a fraction cents less per 1,000 cubic feet than was guaranteed. The Ottawa Company have since been running under their own management, and for the last three months have placed gas in the holder at an average cost of about 3 cents less per 1,000 cubic feet than was called for in the agreement. They are so well pleased that, without asking other companies to bid, they have now closed another order with the Economical Company for a second set of the improved 'Lowe' apparatus, as built by them, to have a capacity of 250,000 cubic feet, and to be erected immediately under the same guarantee as the first set installed."

THE Fort Wayne (Ind.) Gas Company, which is now owned and operated by parties interested in the local natural gas company, has decided to practically rebuild its works, and by a more liberal policy in its management, added to the intention to supply a better quality of gas than that hitherto sent out, the Company believes that it will soon bring the works, together with the output thereof, abreast of plants of equal size. As an earnest of this intention, the proprietors have awarded a contract to the Western Gas Construction Company for a double set of that Company's improved water gas apparatus, the same to be put up on the site formerly occupied by a stack of coal gas benches. The first set is to be a 6-foot set complete, including iron floor, hydraulic elevator, boiler, exhauster and necessary pipe connections. On completion of

the first set, work on the second will be commenced. It is thought that the plant will be in operation by October 15th.

AT the annual meeting of the Fall River (Mass.) Gas Works Company, the officers chosen were: Directors, J. S. Brayton, O. S. Hawes, Geo. P. Brown, S. T. Bodine, Randall Morgan, Henry Lewis and David Payton. The Directors selected the following executive management: President, John S. Brayton; Clerk and Manager, G. P. Brown; Treasurer, E. C. Lee.

A RECENT number of the Boston *Advertiser* said: "There was some talk recently by people interested in gas securities largely held in Boston, over the reduction of the Charlestown Company's dividend from a 10 to a 6 per cent. rate, and the Malden and Melrose Company's from 8 to 6 per cent. Both have reduced the price of gas by order of or in consultation with the Board of Gas and Electric Light Commissioners, and neither has found, in these times of economy by consumers, that consumption has greatly increased owing to the reduction in price. The Malden and Melrose Company has decided to make betterments in the plant, owing to the talk of competition in Medford and Everett. It is unlikely that this talk of competition has substantial basis in the facts, for competition against small companies is not likely till the outcome of cheaper gas can be definitely decided in more prosperous general conditions among consumers. With the growth of suburban cities, gas plants must be maintained at a high degree of perfection in order to meet a growing demand, and stockholders will not be disposed to grumble if dividends are cut no lower than 6 per cent. in these times, with that object in view."

PRESIDENT SPENCER, of the Monmouth (Ills.) Gas Company, has authorized the United Gas Improvement Company to erect a junior setting of the U. G. I. Company's improved Lowe water gas apparatus at Monmouth. The contract also calls for a storage oil tank and other machinery that pertains to such a plant. It is President Spencer's intention to discontinue the manufacture of coal gas on the completion of the water gas apparatus.

THE coke elevator and a number of coke bins, at the Race street plant of the Cincinnati Gas Light and Coke Company, were more or less damaged by a fire, which it is presumed was caused by the careless depositing in the bins of hot coke which had not been properly quenched. The loss was something under $1,500.

THE Dyer Creek Gas and Coal Company, of Dyer Creek, Ind., has been incorporated by Messrs. Adam Huffman, Jesse Wise and Z. Conrad.

THE Berlin Iron Bridge Company, of East Berlin, Conn., has received the contract from the Delaware, Lackawanna and Western Railroad for an anti-condensation corrugated iron roof to cover the railroad company's new engine room at the Auchincloss shaft. This is the third roof of the kind that the Delaware, Lackawanna and Western Railroad proprietors have purchased from the Bridge Company, which goes to show the positive merits of this system of protecting the corrugated iron on the under side from dripping.

THE following correspondence between Mayor Wanser, of Jersey City, N. J., and Mr. R. W. Elliott, Agent of the U. G. I. Company, at Jersey City (which Corporation is in control of the gas supply of that place), will be read with interest:

"JERSEY CITY, N. J., July 10th, 1894.

"R. W. ELLIOTT, Agent the United Gas Improvement Company, Jersey City, N. J.: Dear Sir—At the present time, when our principal cities are engaged in the pursuit of obtaining the best gas at the cheapest rates, and while the settlement of the issue made is resulting in success in other municipalities, and their inhabitants are beginning to enjoy the lower gas rates, it seems a hardship on the people of Jersey City to have to endure the yoke that others have cast off. It is particularly obnoxious to our people to see our city rated at the top prices in gas lighting, while other cities are down the scale, showing continuously decreasing gas rates. As you are well aware, one of the main advantages that a progressive municipality can offer is that of the cheapest and best lighting, because that is one of the necessary expenses of living in cities, and I feel that upon consideration you will agree with me that the present high rate is deterrent to our progress and a subject of continued complaint and oppression upon our people. As the head of our local government, I have for some time felt that some stringent measures should be adopted toward obtaining some relief in this matter, but have hesitated to act until this time in the hope that your Company would take advantage of the experience of contemporaries in other cities and establish yourselves in popular favor by meeting the issue half way, treating it in a dignified and magnanimous manner, and getting the credit thereof. I entered the office with a contract with your Company providing for the gas lighting of the city for five years, in which contract a minimum of lights was provided, making it impossible to retrench in this regard if the city would. That contract is still under consideration by the courts. It is the individual consumer's gas bills that I now have in mind. The condition of the taxes, streets, water, good government generally, gas and transit determines the growth of cities, and the authorities are held responsible for so much of these essentials as they directly control; so much of them as supplied by private capital must serve the public to the city's welfare. The new improvements in gas making which lower the cost of making gas, the consequent lowering price furnished by the Companies to other cities, must be put in practice here. I believe that your Company will see that it is good business to gain more customers by helping to make a larger city, and I think lower gas rates will be to your immediate benefit. Very respectfully, PETER F. WANSER, Mayor."

THE reply by the Company to Mayor Wanser was as follows:

"UNITED GAS IMPROVEMENT COMPANY,
"109 Montgomery Street,
"JERSEY CITY, July 26th, 1894.

"HON. PETER F. WANSER, Mayor Jersey City: Dear Sir—Your favor of the 10th inst., duly received, has been laid before my Board. While I cannot agree with all the propositions set forth in your letter, I am glad to be able to announce to you that in response to your request the price of gas to private consumers will be decreased to $1.50 per 1,000 cubic feet, net, on all gas supplied from and after the 1st of September, 1894. Very truly, R. W. ELLIOTT, Agent."

THE Pittsfield (Mass.) Gas Company, at its annual meeting, re-elected the following officers: President, Robert W. Adam; Treasurer, William Plunkett; Superintendent, John F. Dunbar. The annual reports were very satisfactory.

AN explosion of gas recently occurred in the shops of the Cedar Rapids (Ia.) Gas Light Company, which caused damage amounting to $800. No one was injured.

AT the annual meeting of the Northampton (Mass.) Gas Company no change was made in the executive management. A semi-annual dividend of 4 per cent. was declared.

IT is said, by a correspondent, that Fred. Sharpless is likely to be appointed official gas inspector of Minneapolis, Minn., and the same authority asserts that the gas rate for the city will eventually be put at $1.30 per 1,000 cubic feet.

WE are in receipt of a notification from Mr. J. M. Hughey, Receiver of the Hillsboro (O.) Gas and Electric Light Company, that he will, on September 3d, offer for sale at public auction the plant, franchises, real estate and every other possession of the Hillsboro Gas Light Company, and he further avers that no bid will be accepted for the combined properties that does not equal the sum of $13,974.50. The sale will take place at noon of the day named, the auction place to be "at the door of the Hillsboro Court House."

A SPECIAL meeting of the Directors of the East Albany (N. Y.) Gas Light Company is called for the 22d inst., for the purpose of filling two vacancies in the Board.

THE increase in output at Medina, N. Y., and at Albion, N. Y., since the gas works at these points were taken in hand by Mr. Fennessy and his associates, is not less than 40 per cent., the gain being largely attributable to his intelligent effort in popularizing the use of gas for cooking.

AT a meeting of the shareholders of the Brookline (Mass.) Gas Company, held on the 3d inst., it was determined to increase the capital stock to $2,000,000.

THE tax of 6½ per cent. on the gross receipts of the Cleveland (Ohio) Gas Companies, which is paid into the city treasury, and which is to be ultimately devoted to the construction of a new city hall, now amounts to $87,157.48.

THE gas war in Brooklyn is being carried on in a half-hearted manner, although the pipe laying operations seem to be planned on an extensive scale, notably in the case of the Nassau Company, whose proprietors propose to secure a share of the gas trade in the business portion of the city.

THE AMERICAN GAS LIGHT JOURNAL

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PROPRIETORS.

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MONDAY, AUGUST 13, 1894.

The Market for Gas Securities.

The shorts in Consolidated were brought to with a round turn during the week, a sharp recovery forcing the price up to 121. The opening to-day (Friday) was made at 120½ bid, offered at 121, and the outlook for it is toward higher prices. Our own opinion is that, under the existing circumstances, the stock is pretty near a normal value, with perhaps 125 as the high notch, with the dollar rate discounted. The output of gas this summer by all the city Companies, on account of cooking and mechanical purposes, is little less than phenomenal. Several thousand stoves have been placed, a large percentage of which were ranges of the first class, and despite the hard times and exceptionally bright summer weather we imagine that a net gain in output for the first six months of the year over the corresponding period of 1893 has been the result. Physically, the city gas plants were never in better condition, and in normal times shares in all of them would be a purchase at ruling figures.

Brooklyn shares are a trifle weaker, and the situation there shows no change, the irregular warfare of the past year or so being maintained. At current quotations all classes of Brooklyn securities appear to be above the normal. Chicago gas is irregular but strong, the net gain in the bid price for the week having been 2 points. It opened to-day at 74⅞ to 75. Laclede common and preferred are higher, 18 being freely offered for the former. Bay State is weak and dull, and Baltimore Consolidated is again at 66½ bid. The Hillsboro (Ohio) gas and electric light properties will be sold at Receiver's sale on September 3d.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.

16 WALL ST., NEW YORK CITY.

AUGUST 13.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	120½	121
Central	500,000	50	100	—
" Scrip	220,000	—	100	—
Equitable	4,000,000	100	—	182
" Bonds	1,000,000	—	106	108
Metropolitan, Bonds	658,000	—	108	112
Mutual	3,500,000	100	150	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	80	95
" Bonds	150,000	—	—	100
Richmond Co., S. I.	348,650	50	50	—
" Bonds	100,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	25	30
Preferred	5,000,000	100	80	—
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	102	104
Citizens	1,200,000	20	50	—
" S. F. Bonds	320,000	1000	—	101
Equity Gas Light Co.	2,000,000	100	—	—
Bonds	1,000,000	—	—	—
Fulton Municipal	3,000,000	100	—	126
" Bonds	300,000		103	—
Peoples	1,000,000	10	—	70
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	98	100
Metropolitan	870,000	100	—	136
" Bonds (5's)	70,000	—	—	155
Nassau	1,000,000	25	—	155
" Otfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	135	140
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Bay State Gas Co.—				
Stock	5,000,000	50	13	13½
Income Bonds	2,000,000	1000	60	—
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	78	—
2d " " "	3,000,000	1000	57	58
Buffalo Mutual, N. Y.	750,000	100	120	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	160	—
Chicago Gas Company.	25,000,000	100	74⅞	75
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	81⅛	81½
Consumers Gas Light Co., Jersey City	2,000,000	100	54	57
Bonds	600,000	1000	92	—
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	184½	187
Central, S. F., Cal.			90	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt.	11,000,000	100	66½	—
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
Con. Bonds			—	58
East River Gas Co., Long Island City	1,000,000	100	—	—
Bonds	500,000	100	89¼	—
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
Hartford, Conn	750,000	25	120	128
Jersey City	750,000	20	190	200
Louisville, Ky.	2,570,000	50	125	130
Laclede Gas Light Co. St. Louis, Mo.—				
Common Stock	7,500,000	100	18	18¼
Preferred "	2,500,000	100	68	70
Bonds	9,034,400	1000	86½	87½
Little Falls N. Y.	50,000	100	—	160
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
New Haven, Conn.		25	200	—
Oakland, Cal.			42⅜	43
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Peoples, Jersey City	500,000	—	175	185
" " Bonds			—	—
Paterson, N. J.		25	99	102
Rochester, N. Y.		50	80	85
Preferred			90	95
Bonds			90	95
Syracuse, N. Y.	500,000	25	—	—
San Francisco Gas Co. San Francisco, Cal.	10,000,000	100	71	71½
Washington, D. C.	2,000,000	20	240	—
Wilmington, Del.	500,000	50	180	182

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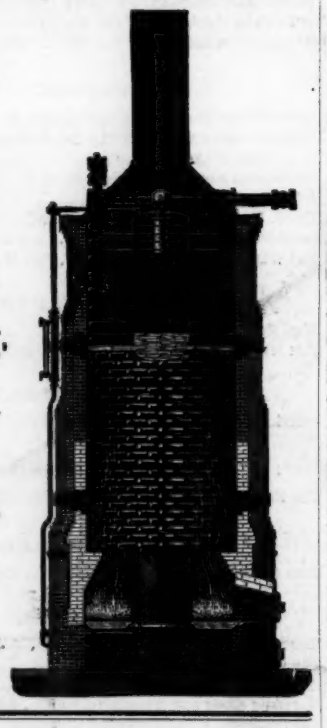

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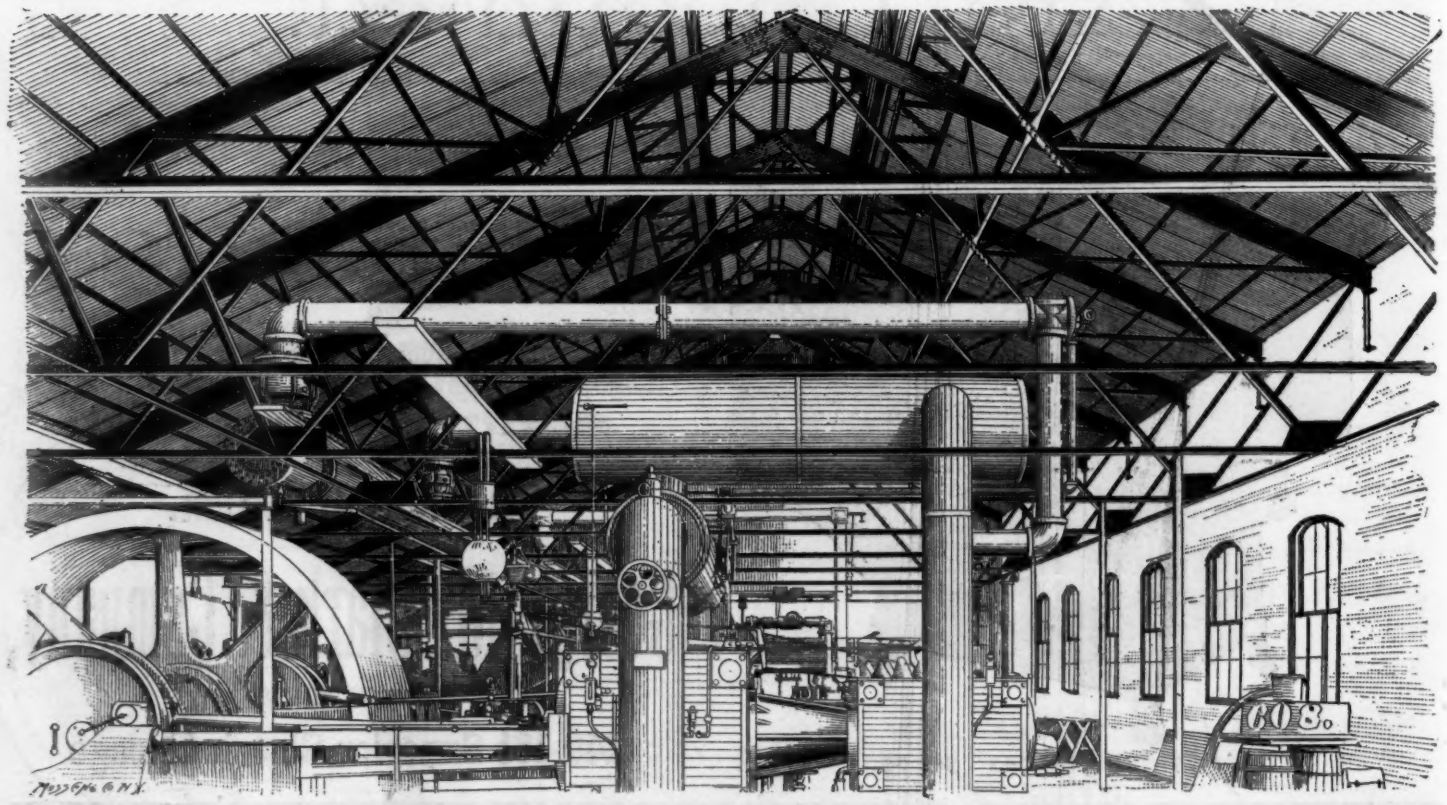

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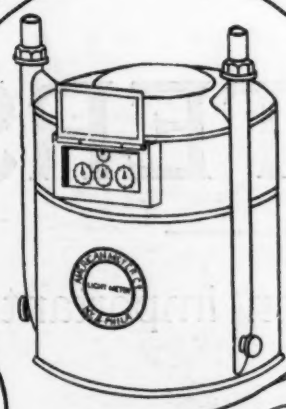

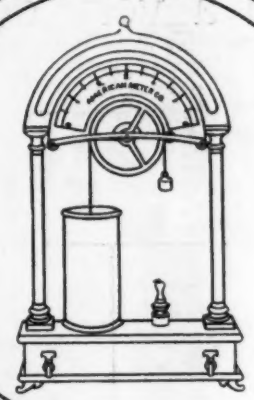

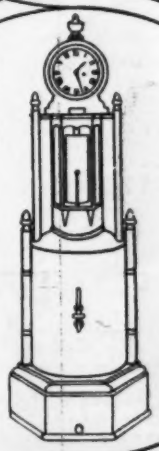

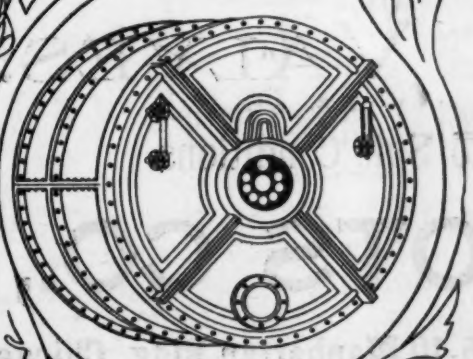

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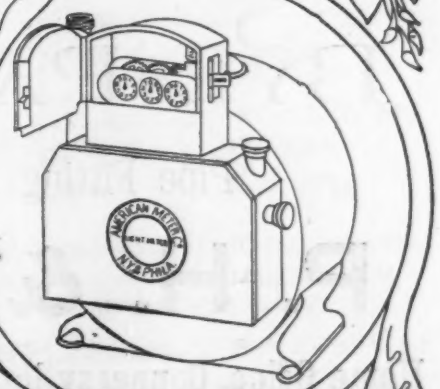
PUBLIC LIGHTING TABLE.

AUGUST, 1894.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. Extinguish.
				P.M.	A.M.
Wed.	1	7.40 PM NM	4.00 AM	7.10	3.30
Thu.	2	7.40	4.00	7.10	3.30
Fri.	3	7.40	4.00	7.10	3.30
Sat.	4	7.40	4.00	7.10	3.30
Sun.	5	7.40	4.00	7.10	3.30
Mon.	6	9.00	4.00	7.10	3.45
Tue.	7	9.20	4.00	7.10	3.45
Wed.	8	9.50 FQ	4.00	7.10	3.45
Thu.	9	10.30	4.10	7.10	3.45
Fri.	10	11.10	4.10	7.10	3.45
Sat	11	12.00	4.10	7.10	3.45
Sun.	12	12.50 AM	4.10	7.10	3.45
Mon.	13	1.50	4.10	6.55	4.00
Tue.	14	3.00	4.10	6.55	4.00
Wed.	15	No L.	No L.	6.55	4.00
Thu.	16	No L. FM	No L.	6.55	4.00
Fri.	17	No L.	No L.	6.55	4.00
Sat.	18	7.20 PM	9.00 PM	6.55	4.00
Sun.	19	7.20	9.20	6.55	4.00
Mon.	20	7.20	9.40	6.45	4.10
Tue.	21	7.20	10.00	6.45	4.10
Wed.	22	7.20	10.30	6.45	4.10
Thu.	23	7.20	11.10	6.45	4.10
Fri.	24	7.10 LQ	11.50	6.45	4.10
Sat	25	7.10	12.50 AM	6.45	4.10
Sun.	26	7.10	1.50	6.45	4.10
Mon.	27	7.10	4.20	6.30	4.20
Tue.	28	7.10	4.20	6.30	4.20
Wed.	29	7.10	4.30	6.30	4.20
Thu.	30	7.10 NM	4.30	6.30	4.20
Fri.	31	7.00	4.30	6.30	4.20

TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	244.10	January	433.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45



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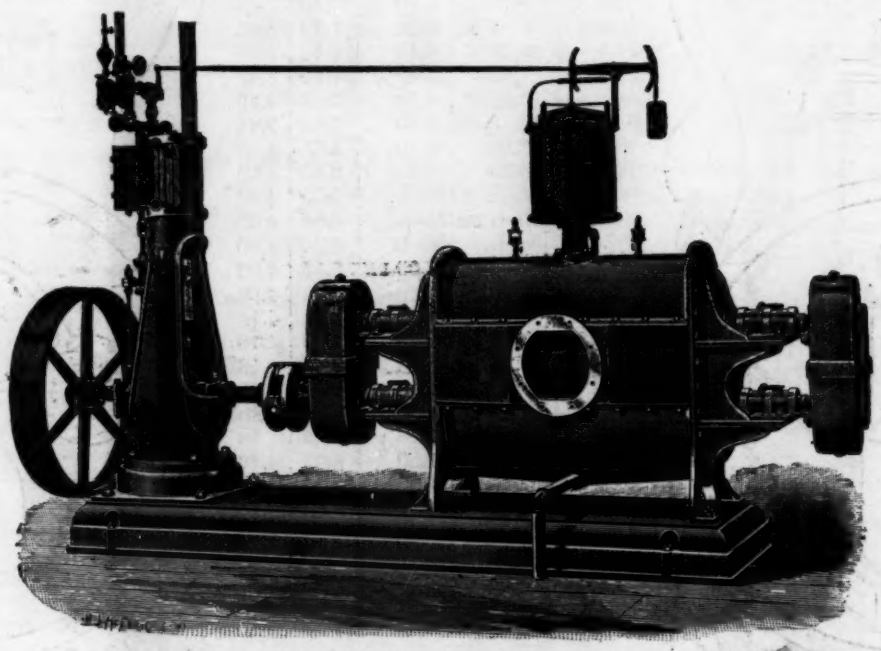

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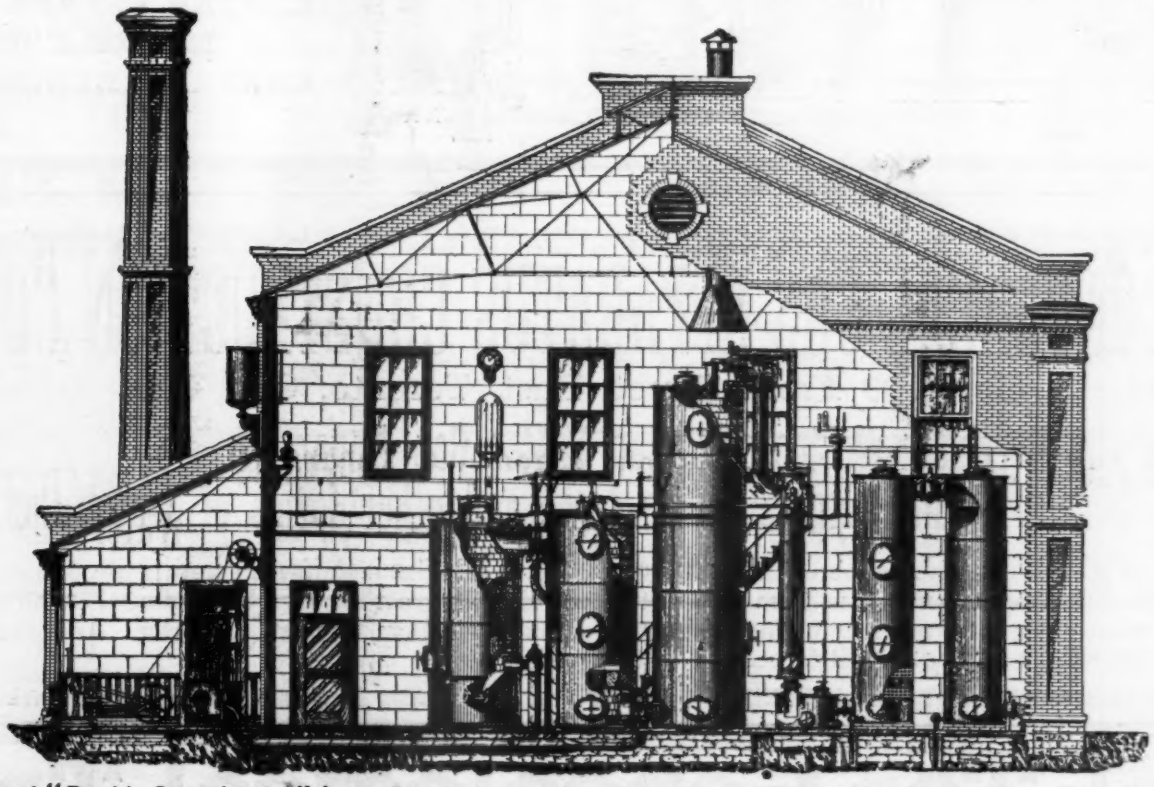

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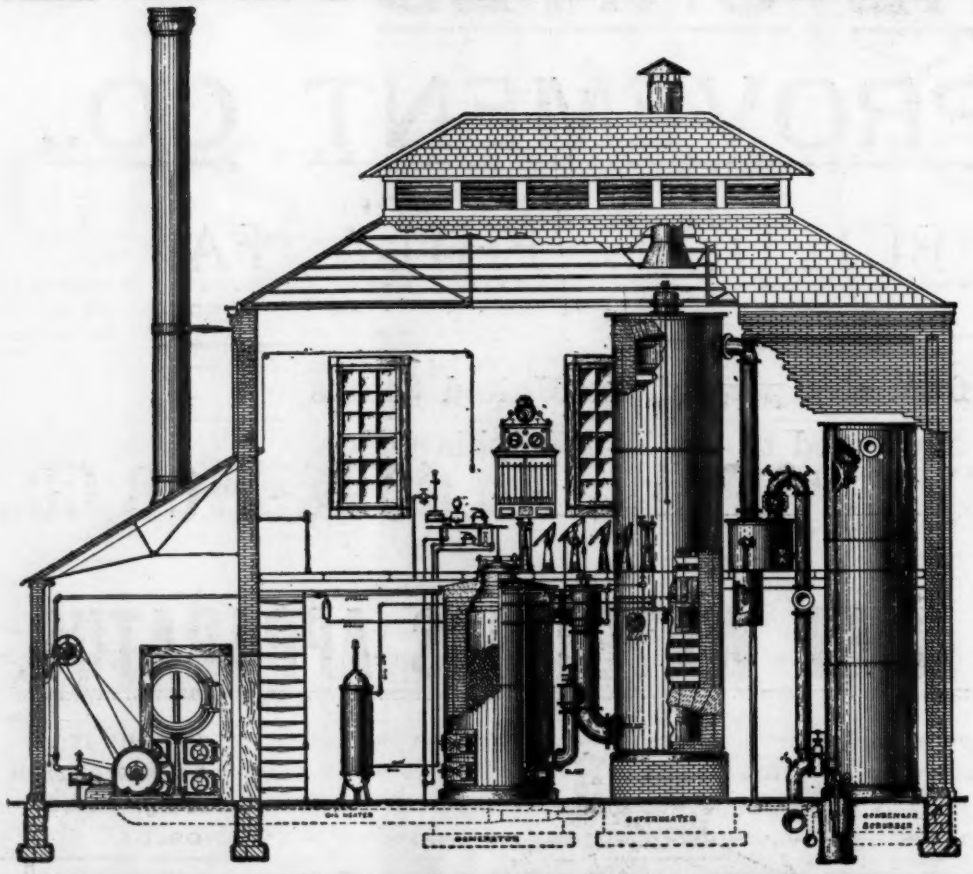

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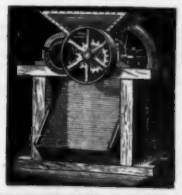

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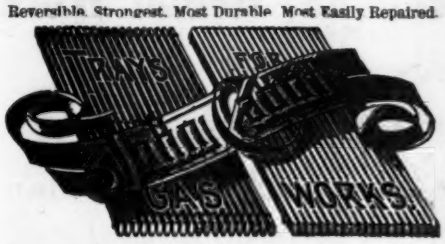

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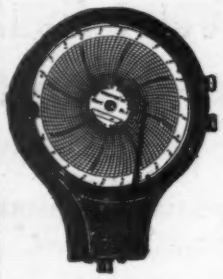

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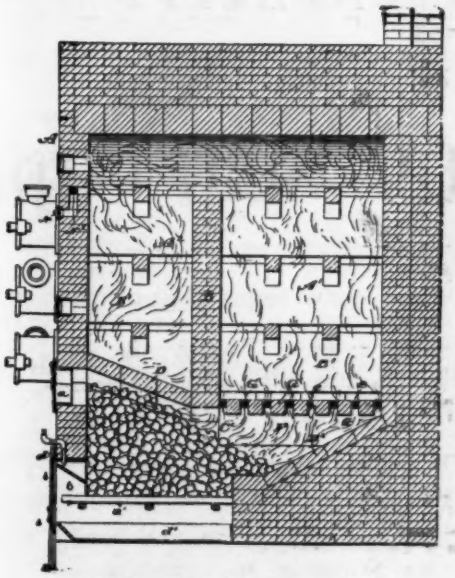

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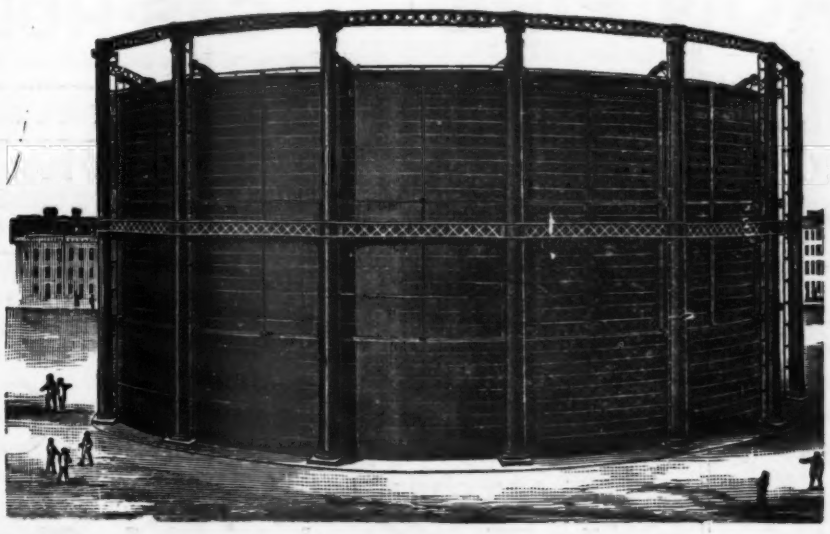

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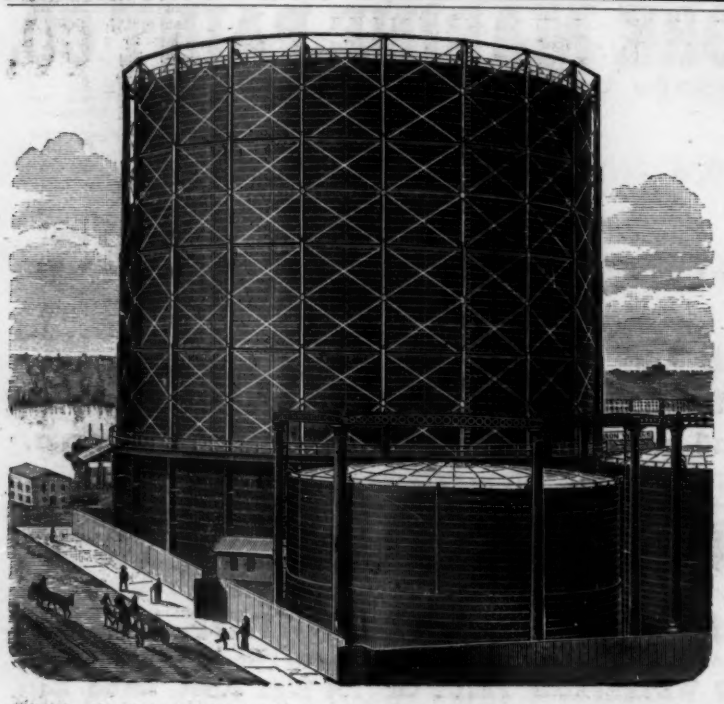

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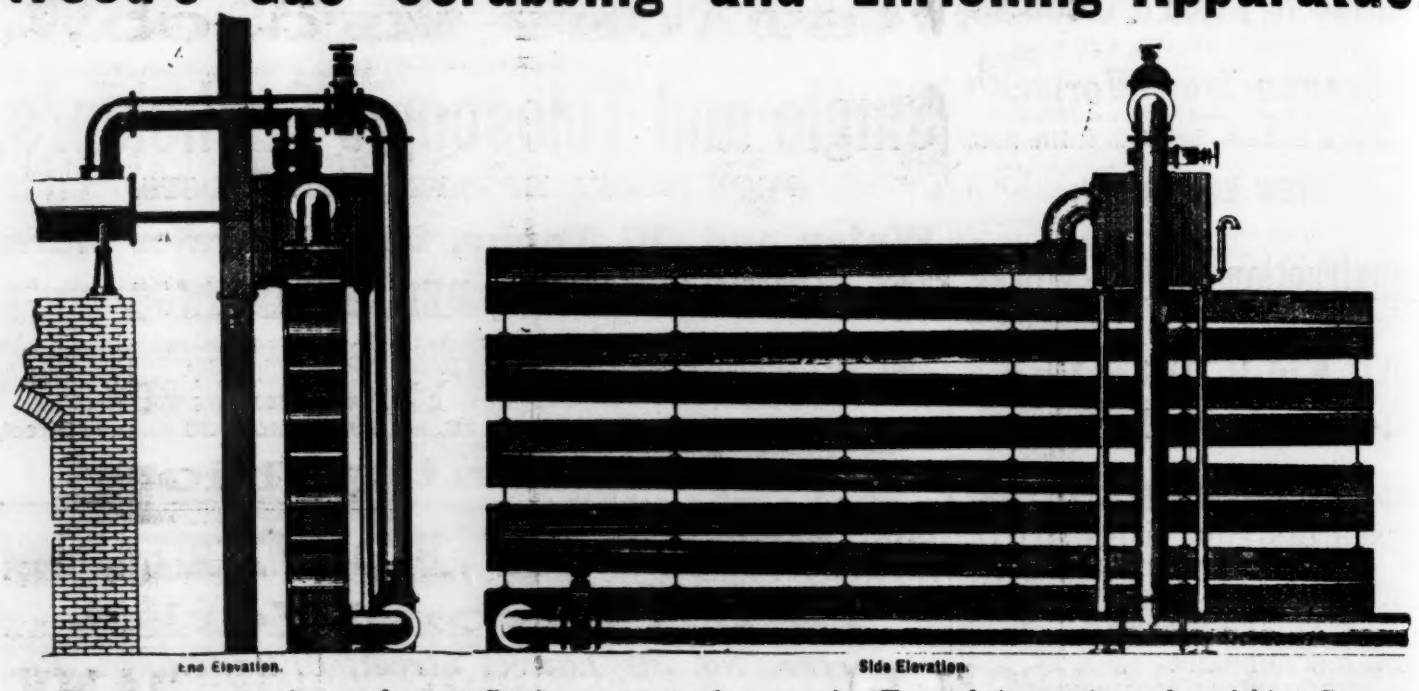

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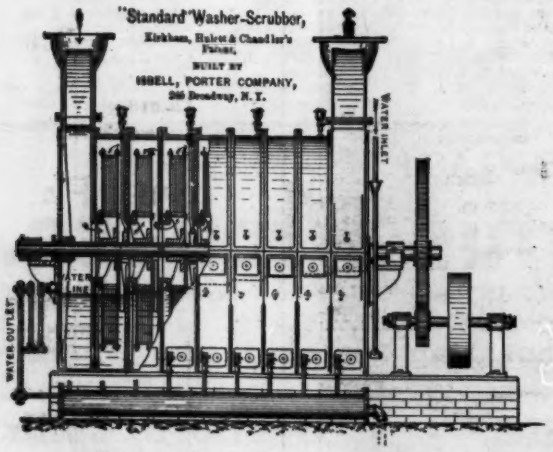

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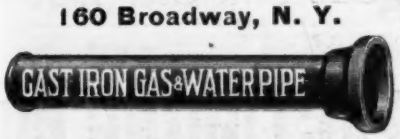

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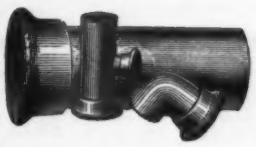

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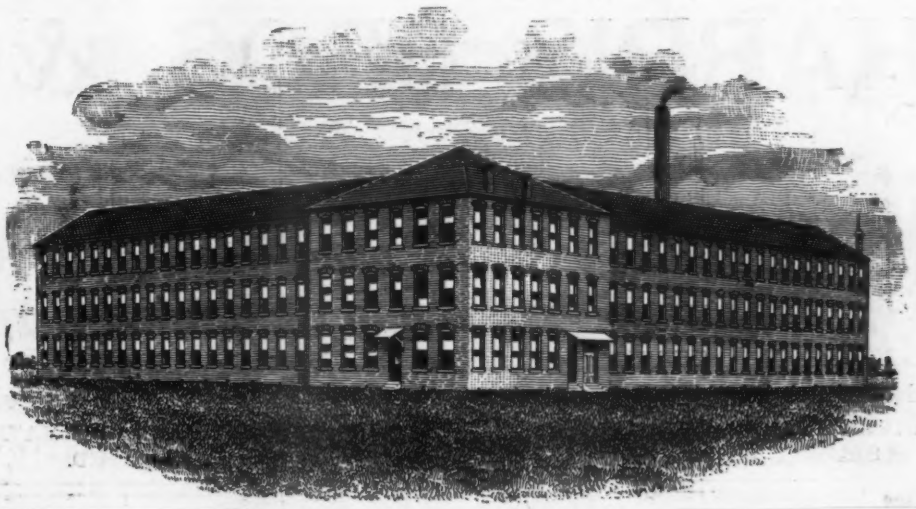

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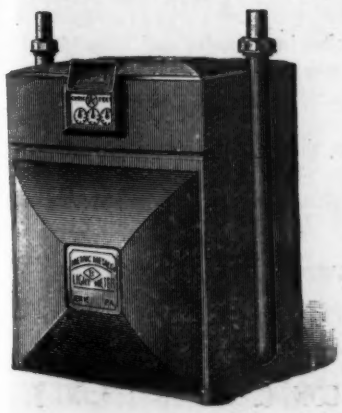

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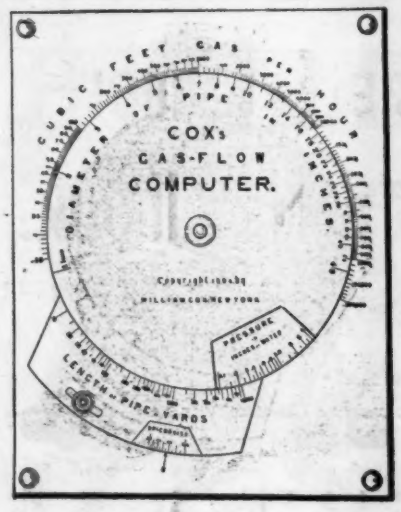

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